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# PYC WARMCEL

**A Passive House is a comfort house.** The largest growth sector for cellulose fibre in the construction market is in Passive House certified projects. Injection into wall and roof voids gives a high density packing which helps cut out thermal convection and conductivity and significantly reduces noise levels. The pioneer of the Passivhaus movement, Wolfgang Feist quoted that perhaps a better name for a 'Passive House' would have been the "Comfort House".

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# editor's letter

The old management adage "you can't manage what you don't measure" is fundamental to low energy building. After all, what's the point of our industry spending time, effort and money on making supposedly low energy buildings if we don't check how they're actually performing. Is it because we won't like what we discover?

Looking at Ireland and the UK's energy standards for new buildings, Ireland appears to take the view that it's best to aim high (in the case of dwellings at least) but not monitor how the resultant buildings are actually performing, while the UK is instead aiming much lower but is actually monitoring performance. Really, given how high the stakes are in terms of climate change, energy supply and the needless running costs and discomfort of sub-standard buildings, we need to be aiming to design and build ultra low energy buildings, and we need to monitor those buildings – or representative samples of those buildings – to see whether the approaches we try out actually work or not, and to feed that information back into how we legislate, design and build.

Calculated and actual performance can differ wildly, for a variety of reasons, and we shouldn't assume that buildings with energy performance calculated to comply with building regulations will actually perform to those levels. Sadly we have no reason to expect this to be the case. For its part the Westminster government recognises that a significant performance gap exists between designed and actual energy use of notionally low energy buildings in the UK, and although its regulations are much worse than Ireland's on paper, the government has pledged to eliminate the performance gap in England, stating that by 2020 90% of all new homes will perform as well as or better than designed, with substantial and detailed analysis ongoing at present by the Zero Carbon Hub to establish the causes of this gap. The Irish government appears not to share these concerns. There hasn't been an attempt since 2005's still unpublished Energy Performance Survey of Irish Housing to check whether the actual energy performance of new build homes corresponded to the calculations. A cynic might argue that the widespread non-compliance with building regulations – and, perhaps unsurprisingly, correspondingly higher than expected energy usage – noted in that study, serves a powerful disincentive for the authorities to commission further research.

And while to an extent poor performance may be down to non-compliance with regulations, there are broader questions about some of the assumptions made in the regulations and more particularly in the associated documents. I contend that it's possible to satisfy Ireland's technical guidance documents or the UK's approved documents – and therefore show prima facie compliance with the regulations – and still produce a building that fails. Some of the "natural" ventilation strategies that abound, coupled with ropey thermal bridging and airtightness performance are causes for particular concern.

So it's critical that we don't just take a tick box approach to compliance, but actually design and construct buildings that work – buildings underpinned with a sound theoretical basis and strong empirical evidence of actual performance. Part of the reason my company rebranded our magazine from Construct Ireland to Passive House Plus was because of our conviction that the passive house standard offers a tried and tested route to delivering ultra low energy, healthy, robust buildings. We're not saying that everyone should build a passive house, but we think we all have a lot to learn from the principles and rigorous attention to both a priori and empirical data which underpin its approach.

Regards,
the editor

International PASSIVE HOUSE Association iPHA

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GREEN AWARDS 2010 WINNER Green Communications Award

Jeff Colley: winner green leader award -Green Awards 2010

Construct Ireland: winner green communications award -Green Awards 2010


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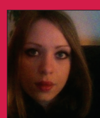
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**Cover: River Studio Enerphit**
**Photograph: Marco da Cruz**

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# contents






# News

## NZEB focus at UK Passivhaus Conference

Photos: Philip Wade Photography

The 2014 UK Passivhaus Conference was held in Stevenage on 16 October, and central to discussions were EU targets for near zero energy buildings and how these relate to passive house.

By 2021, all new buildings in the EU will have to be 'nearly zero energy buildings' (NZEBs), though each country will come up with its own definition of this term. Speaking at the conference, Jessica Grove Smith of the Passive House Institute said: "A passive house is definitely a near zero energy building, but not all near zero energy buildings are passive houses. Of course, we think they should all be." NZEBs will have to generate some renewable energy, and partly with an eye to this, the Passive House Institute has introduced new certification categories – Passive House Plus and Passive House Premium – that reward renewables. (The new categories and the rationale behind them are explained in an article by the Passive House Institute's Dr Benjamin Krick on pp62-65.)

The requirements of the UK's 2016 national zero carbon standard, which the UK government says will meet its NZEB obligations, will likely lag well behind passive house. Nevertheless David Adams, the director of the Zero Carbon Hub (set up to advise the government on the standard) asked those attending to defend the hub's recommendations (based around a fabric standard of around 40 to 45kWh/m$^2$/yr, depending on building form), for fear these would be further diluted by industry. He pointed out that crucially, a requirement for as-built performance had been introduced to help tackle the performance gap.

Meanwhile Sebastian Moreno-Vacca of Brussels-based architects A2M told the conference about how, in 2011, the Belgian capital legislated that all new buildings must meet the passive house standard from 2015. "We legislated first and discussed afterwards," he said.

Some prominent passive house clients at the conference emphasised that comfort, health and fuel poverty relief — rather than carbon — were their reasons for procuring passive buildings. Emma Osmundsen, housing manager at Exeter City Council, said: "We are focused on addressing need, for those in greatest need. We are aiming to lift people right out of fuel poverty. And we want the buildings to be healthy."

It was notable at the conference that passive house is no longer seen as an extravagance — not least because in some instances, it has been the money-saving option that has allowed a cash-constrained scheme to go ahead. At the Hereford Archives & Records Centre, as Architype's Mark Barry reported, the original brief was for a building built to the BREEAM Very Good standard, but the budget was cut and it looked like the building would not go ahead. "We offered to do passive house at a 4.5% capital saving and much lower running costs, and the project became viable for the client and went ahead," Barry reported.

Other projects that had to include renewables to meet various sustainability specifications made valuable savings by designing to the passive house standard, enabling the outlay on renewables to be reduced or even eliminated. The conference also heard that the increased asset value of passive buildings is being formally recognised now, with Jon Lefever of Hastoe Housing Association reporting that he had received a valuation for some homes under construction that added £10,000 per unit based on their passive house certification.

From a purely commercial point of view, the conference also heard that landlords are judging that building to passive house gives them the theoretical option of charging higher rents, important when raising finance. Finally, the conference also heard that while post-occupancy surveys have revealed occupants of new passive dwellings are delighted with their homes, there have a been a few reports of overheating. But Martin Ingham of Linktreat Ltd said it was principally householders who had yet to fully grasp how to manage their homes for cooling who reported discomfort. (Report by Kate de Selincourt. A longer version of this article is online at www.passive.ie).

(above) Speakers at the 2014 UK Passivhaus Conference included the Passive House Institute's Jessica Grove-Smith, Zero Carbon Hub director David Adams and Exeter City Council housing manager Emma Osmundsen

## Corrections

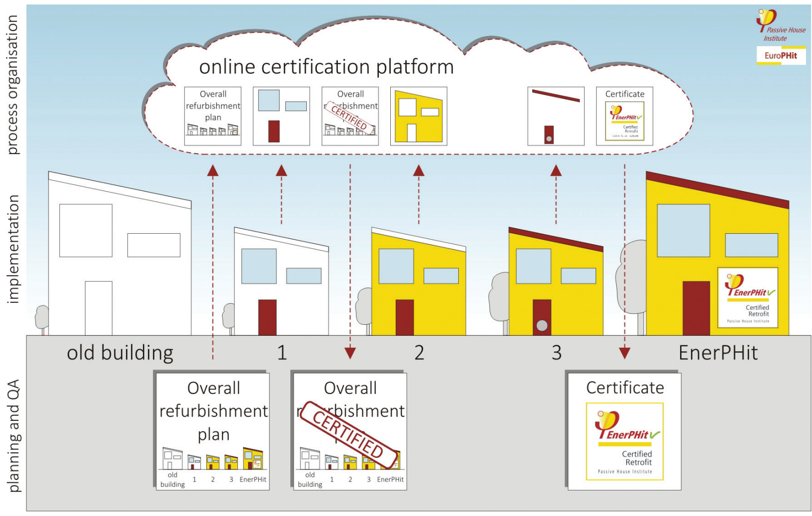
In the article 'How to save social housing blocks' in issue eight, we wrongly quoted David Williams of Eastlands Homes as saying: "The residents in the maisonettes are the poorest people in our housing stock". This was a misquote. His actual words were, "the maisonettes are the poorest in our housing stock", and the quote was from an article in Inside Housing magazine, who we should have credited.

In the same issue, we wrongly attributed photography for the Riedberg school, youth centre & gym in our 'International Selection' feature to Achim Große. The photographs were in fact by Thomas Herrmann. We apologise for these errors.

# News

## Passive House Institute announces Component Award & wins refurb award

Images: Passive House Institute




The Passive House Institute has announced the launch of its second annual Component Award, which honours the best passive house certified windows. This year the award will particularly reward windows that are suitable for step-by-step retrofit projects, where there might be significant time gaps between different elements of the renovation.

According to a statement from the institute: "This time the focus will be on windows which provide good results both during the transitional period without façade insulation as well as after completion of the refurbishment." The winners will be announced at the International Passive House Conference, which will be held from 17 - 18 April 2015 in Leipzig.

"The Component Award 2015 will primarily assess the cost efficiency of passive house windows within the context of building refurbishment; in doing so, the purchase costs will be measured against the potential savings," the statement continued. "The competition jury will also consider the aspects of practicability, innovation and aesthetics."

Categories for the award include wood, wood/aluminium, aluminium and PVC, and any window certified by the Passive House Institute is eligible to enter. The deadline for submissions is 1 February 2015, and further details can be found online at www.passiv.de/en/component-award

Meanwhile the institute has been rewarded by the Refurbishment Road Map competition, held by the Institute for Energy and Environmental Research in Heidelberg, for a concept designed to encourage a high quality approach to step-by-step retrofits — which may be carried out over a long period of time — through the preparation of a comprehensive renovation plan before the first work is undertaken.

A statement from the institute read: "According to this concept, the individual modernisation steps are input into a new version of the PHPP which has been optimised for this purpose. Certification can take place if the overall plan has been reviewed by a certifier accredited by the Passive House Institute and if the first measures have already been implemented; this confirms that the Enerphit standard for refurbishments will be achieved upon completion of the 'road map'. This analysis is thus a precursor to the actual certification of the building which may only be completed years later."

A detailed description of the project can be found online at europhit.eu/certification-retrofit-plans

(above) Prof Wolfgang Feist (right) and Dr Benjamin Krick (left) of the Passive House Institute meet representatives from M Sora, one of last year's Component Award winners; An illustration of the Passive House Institute's step-by-step refurbishment concept

## PYC Insulation and CIUR announce Warmcel partnership

The UK branch of cellulose insulation manufacturer CIUR, and PYC Insulation Ltd, have announced a new commercial partnership aimed at developing and distributing Warmcel cellulose insulation in the UK and Ireland.

Excel Industries Ltd, the previous manufacturers of Warmcel, went into administration earlier this year. CIUR subsequently purchased manufacturing equipment and branding rights to enable it to continue manufacturing Warmcel.

Michal Urbanek, managing director of CIUR UK's parent company CIUR AS, said: "Since CIUR AS acquired the Warmcel brand and manufacturing plant from Excel Industries Limited, we wanted to set up a strong team in order to continue to develop and support the sales of Warmcel cellulose insulation in the UK. In addition to our excellent manufacturing process and UK technical and commercial team, by


partnering with PYC Insulation we can now offer a much broader package of support to Warmcel installers and work more effectively with architects, specifiers and developers."

Meanwhile, Jasper Meade, MD of PYC Insulation Ltd, said: "After many years of being the largest Warmcel installer in the UK, PYC has restructured and expanded its business. This means that rather than focussing on installing Warmcel, we are now providing technical and commercial development assistance for other Warmcel installers. This involves using our experience and long term relationships with architects, specifiers and developers to grow the market for Warmcel, as well as support with machines and building systems with Warmcel. In order to achieve our goals we needed to find a cellulose manufacturer, with an excellent cellulose fibre product and commercial and technical team. In CIUR we have more than achieved this goal. The continuation of the Warmcel brand in the UK and the formation of our new partnership with CIUR is excellent news for the UK construction sector."

(above) Warmcel insulation will now be available in the UK and Ireland via PYC in partnership with CIUR

# Genvex units bring heat, fresh air & hot water to award-winning scheme

The Burnham Overy Staithe development in North Norfolk picked up a prestigious UK Passivhaus Award in October, and is profiled in depth on page 28 of this issue of Passive House Plus.

Space heating, hot water and ventilation to the dwellings is provided by Genvex Combi 185 compact service units, which combine heat recovery ventilation and an air-to-water heat pump, and were supplied by Total Home Environment.

Consisting of a terrace of three dwellings, these passive house units are part of a larger mixed development of affordable and open market housing developed by Hastoe Housing Association, and lie within the North Norfolk area of outstanding natural beauty."As there was no gas in the area, we were asked to install our compact service unit to not only provide heat recovery ventilation, but via the integral heat pump, all the heating and domestic hot water requirements to each of the houses," Clarissa Youden of Total Home Environment told Passive House Plus.

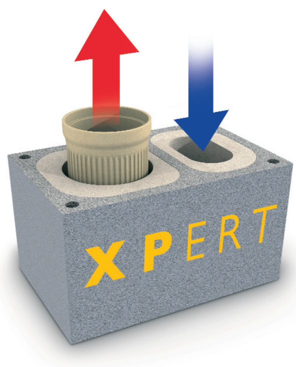
She said that early monitoring indicates performance is as anticipated with heat load hovering around 8W/m², temperature at a constant 21C, indoor carbon dioxide averaging 650ppm and relative humidity averaging 55%.The North Norfolk coast has a significant proportion of second homes, which has driven housing costs beyond the reach of local people, and passive house was specified by Hastoe as a means of addressing fuel poverty in the area.

The Genvex Combi 185 is a Passive House Institute certified combined heat recovery ventilation unit with air-source heat pump. Youden said it can provide heat recovery ventilation at all times, even when the heat pump is delivering hot water, and has a COP (coefficient of performance) of 4.5, according to Total Home Environment. It is an all-in-one compact unit, meaning the system's components are integrated.

A video profile of the Burnham Overy Staithe project, with enthusiastic reports from residents, is also available online at tinyurl.com/bospassive

(above) The Passive House Institute certified Genvex Combi 185, an integrated heating, ventilation and hot water system designed for low energy buildings

# Schiedel launches first passive house certified chimney system




The UK's largest manufacturer of chimney systems, Schiedel Chimney Systems Ltd, has launched the Absolut XPert chimney system with an integrated insulated combustion air shaft. Designed for airtight homes, Schiedel Absolut XPert is the first Passive House Institute certified chimney system worldwide.

Suitable for use with all fuel types, with its GW3 rated ceramic profiled liner, Absolut XPert offers condensate resistance even after a soot fire. Airtightness is built into the system, according to Schiedel.

"Schiedel Absolut XPert represents a comprehensive solution to the four main challenges raised by modern heating technology combined with the latest energy efficient building techniques," said Schiedel's residential sales and marketing manager, David Wright.

The first challenge is condensation forming on the chimney block. If external temperatures are very cold, then moisture from the surrounding air can turn to condensation on the surface of the block, leading to damp spots and potentially mould. The Absolut XPert system employs a core of foam concrete as insulation in the blocks that form the shaft, ensuring that block surface temperatures remain above the critical dew point.

The second challenge is heat transmission to the outside of the building (thermal bridging) via the chimney block. The top and bottom of the chimney are the two most sensitive areas for heat transmission between the warm interior of the house and the cold exterior. The Absolut XPert system has specifically designed thermal insulation blocks to prevent this.

Challenge three is the supply of air to the appliance in an airtight house. When buildings are efficiently sealed against draughts, combustion air has to be brought directly to the appliance. The Absolut XPert system has an integrated insulated air shaft which supplies the appliance with the right amount of air it needs for combustion, drawn directly from above the roof, minimising problems due to prevailing winds.

Challenge four is how to cope with extremes of temperature and provide resistance to condensate even after a chimney fire. The Absolut XPert profiled liner has been tested and approved with a GW3 designation meaning that it is soot fire resistant, condensate resistant even after a chimney fire, and is corrosion resistant on gas, oil and solid fuel applications.

(above) Schiedel's Absolut XPert Passive House Institute certified chimney system

# News

## Green Building Store launches new 'frameless' passive house windows

Green Building Store launched a new passive house certified A-rated timber window range at the UK Passivhaus Conference on 16 October. The new Progression range offers high performance minimalist design with narrow sightlines and 'frameless glazing' for passive house and other low energy projects.

When installed correctly, the Progression frame is hidden within the insulation at the wall junction, giving the appearance of frameless glazing from the outside. The proportion of glazing to frame, and the highly insulated narrow frames, contribute to Progression achieving the Passive House Institute's A-rated window certification.

The Progression frame includes Thermowood thermally-modified timber on external facings, which requires minimal or no maintenance throughout the window's lifetime. Progression uses cork insulation within the frame and laminated spruce for the internal facing timber.

Chris Herring, director of Green Building Store, commented: "Progression offers passive house designers a minimalist, contemporary design and passive house certified A-rated performance. The range perfectly complements our other high performance timber window ranges and we are delighted to be able to bring the Progression range to the UK for the first time."

According to Green Building Store, Progression can deliver whole-window U-values as low as 0.68. Green Building Store are sole UK agents for the Progression range, in partnership with Czech manufacturer Slavona. The range has already been used on Green Building Store's current West Yorkshire new build construction project, the Golcar Passivhaus.

(right) Progression, Green Building Store's new A-rated passive house certified timber window range

## Passive house: an alternative method of meeting Part L?

The passive house standard may be acceptable as an alternative method of compliance with Ireland's stringent energy efficiency regulations, according to a leading expert in energy and construction law, leaving the door open to a similar approach in the UK.

The equivalent of England's Approved Document L1A, Ireland's Technical Guidance Document L for dwellings demands 60% energy and carbon reductions compared to 2005 levels, and requires renewable energy generation – 10kWh/m²/yr of thermal energy or 4kWh/m²/yr of electrical. These changes were heavily influenced by the campaigning work of this magazine's predecessor, Construct Ireland.

But as with the UK regulations, the detail on compliance is contained within guidance documents, rather than in the regulation of Part L itself. As legal expert Philip Lee writes in the Irish edition of Passive House Plus issue 9, guidance documents don't have the force of law, meaning alternative methods of compliance – such as passive house – could conceivably be used.

Curiously, buildings that go beyond Ireland's 60% energy reductions can struggle to meet Ireland's renewable energy targets, as they may not have sufficiently high energy demand to easily meet the 10kWh/m²/yr renewables target. Irish passive house advocates have long argued that dwellings meeting the standard should not be required to generate such quantities of renewable energy.

According to Lee: "It could be argued that the proportion of renewable energy to fossil fuels inherent in the technical guidance document could also be applied to a passive house. Therefore, if a passive house consumes 50% less primary energy, then the "proportion" of renewables set out in the technical guidance document, namely 10 kWh/m² (heating) and 4 kWh/m² (electrical energy), should be reduced by 50% to 5 kWh/m² and 2 kWh/m² respectively."

"An alternative approach to the same interpretation of "reasonable" would be to look at the net balance of brown energy that is produced in a standard house and compare that to the net brown energy produced in a passive house. Provided that the net amount of fossil fuel being consumed in the passive house is less than that being consumed in a standard house then it could be argued that any actual energy coming from renewable sources would meet the 'reasonable test'."

Lee also points out that under the RES Directive, EU members states must "require the use of minimum levels of energy from renewable resources" both in new buildings and existing buildings that are subject to major renovation, from 31 December 2014. This means, he says, that Ireland's Part L will be in breach of the directive if it is not quickly updated, as it specifies a "proportion" of renewable energy rather than a minimum amount. He warns that targets set in a guidance document don't suffice, given their non-mandatory status. The four regions of the UK are also set to be in breach, based on current policy.

Lee points out that the directive encourages member states to take into account "national measures relating to substantial increases in energy efficiency" and to "passive, low or zero-energy buildings" when updating their building regulations to increase the share of renewable energy.

# News

## Passive house certification crucial for quality assurance — Kym Mead

Leading passive house expert and building certifier Kym Mead has advised those procuring or building passive house projects of the importance of having their building certified.

Mead is a director of his own consultancy, Mead: Energy & Architectural Ltd, which provides passive house certification and consultation, and is also an associate director of the UK's Passivhaus Trust. He is a former head of low carbon buildings at the BRE and is an architect by training.

"It's about quality assurance," he said, speaking on the importance of certification. "The design team could overlook something that may have a negative effect on the building's performance, or an honest mistake could be made. Certification is essentially a third party audit, making sure that something hasn't been missed. It's about peace of mind for the client. It's always advisable to have the building checked over and signed off by a certifier at the design stage, so any feedback can be incorporated easily, and cost-effectively."

Mead believes the term passive house should only refer to certified buildings in order to protect the integrity of the standard, with the term 'passive house principles' being more appropriate for referring to buildings that meet the requirements of the standard in PHPP but aren't certified.

Clients who build to the passive house standard but don't get their project certified sometimes cite cost as a reason for declining certification, but Mead points out the cost per square metre for certification is small compared to other elements of a typical build. "It's actually one of the cheapest things to do," he said.

Mead has completed an internship at the Passive House Institute in Germany where he was able to work closely with the institute's team and gain valuable experience. He added that because in the UK the passive house standard represents a level above what's considered best practice, certification enables clients to be certain this robust standard has been met.

(right) Kym Mead argues that bringing in passive house certifiers at the design stage can deliver cost savings and avoid mistakes being made

## Ecological Building Systems launch airtightness & fabric training programme

Following a successful World Green Building Week series of seminars and demonstrations in September, Ecological Building Systems has announced a series of new training courses and seminars. "This is timely with the latest revision of the building regulations, increased activity in the construction sector and a demand for higher levels of thermal performance in buildings," said Niall Crosson, the company's technical engineer and certified passive house consultant.

The courses include a new Pro Clima 'Intelligent Airtight Systems' training programme which has a particular focus on practically delivering airtightness on site. This practical course will be delivered by one of Ecological Building System's technical experts, Peter Smith, in combination with certified passive house tradesperson Roman Szypura of Clioma House. Roman is very well known in the world of passive house and has many years' experience delivering some of the most airtight and lowest energy houses in Ireland and the UK.

Ecological Building Systems will also once again be delivering its highly commended Better Building, Putting the Fabric First course. This is split into morning theoretical and afternoon

practical sessions. The morning building physics section is delivered by Niall Crosson. The practical afternoon session is again delivered by Roman Szypura. The course focuses on meeting the thermal requirements of the building regulations, key areas to consider when retrofitting existing buildings, an introduction to passive house principles, and an overview of airtightness and vapour control. This course will focus on both retrofits and new builds.

The courses will be held at the company's state-of-the-art Centre of Knowledge in Athboy, Co Meath. The courses are also targeted at UK delegates, and the company can organise transport to and from Dublin Airport. Given the company's vast experience using award winning products on pioneering low energy projects since the year 2000, Ecological Building Systems is in a unique position to impart its knowledge to both building professionals and the public.

More information regarding these seminars and training courses is available at: www.ecologicalbuildingsystems.com

Ecological Building Systems also provide free consultation and guidance, and its training centre is open for free viewing by appointment. The company is always available to help guide building professionals through design detailing, product choice and advice on installation.

(above) David Broderick of DB Plaster demonstrating how to install Gutex insulation at the Ecological Building Systems Centre of Knowledge

# News

## Green Tomato launches sash-lookalike ultra low energy window

Photos: Joana Saramago / 4C Associates

Green Tomato Energy has launched a triple-glazed sash-lookalike timber window to the UK market. The window is designed to resemble a traditional sash window, making it ideal for historic buildings, while offering the thermal performance of a modern ultra low energy window.

The window's top sash is fixed in in place so it cannot be opened, while the bottom sash opens on a tilt-and-turn mechanism rather than the traditional sliding sash. It was developed by the team working on the Lena Gardens and Princedale Road passive house retrofit projects in London, where there was no other solution that would meet the passive house airtightness standard and comply with the strict conservation criteria laid down by the planners. Traditional sliding sash windows are notoriously difficult to make airtight so aren't suitable for passive house projects.

The Green Tomato Energy window has since been used on the firm's Enerphit project at Barmouth Road, London, which was profiled in issue eight of Passive House Plus, and the design of the window has continued to evolve.

The windows are made in a small workshop in Cambridge, and according to Green Tomato Energy, this means the usual reasons for delays in supply to the UK (ie transport) are less of an issue. The window features triple-glazing, a layer of gaskets for high levels of airtightness and sound insulation, plus a low-e coating, argon fill and warm edge spacer bar. The window offers U-values of 0.58 for the glazing and 1.10 for the frame, and a G-value of 0.55.

(above) The Green Tomato sash lookalike window at the Barmouth Road Enerphit project in London, as featured in issue 8 of Passive House Plus

## Advantage Austria to run passive CPD events in 2015

After the success of recent workshops in London and Edinburgh on passive house and low energy buildings, Advantage Austria has announced plans for further workshops in 2015.

The exact venues for future events have yet to be decided but Peter Franklin of Advantage Austria told Passive House Plus he is keen to strengthen links in all regions of the country.

"It was great to see so many initiatives on low energy building up and running in Scotland, especially the work that is being done by the colleges network. We would love to hear from organisations keen to promote sustainable building in other parts of the country who might be interested in hosting future events," he said.

More events are planned for Scotland too, where Franklin said there is a lot of interest from the educational sector as well as the local construction industry to fully understand the opportunities and challenges of low energy building.

Advantage Austria's mission is to get experts from Austria and the UK talking to each other to promote better sustainable building practices in both countries. In March, Advantage Austria will bring a group of architects and engineers from Austria to exchange ideas with their UK counterparts and learn about new developments in the UK market. You can meet them at a forum at the Austrian Trade Commission in London on 2 March or at the Austrian Pavilion at Ecobuild the following afternoon.

Some of Austria's leading low energy brands contributed to events in 2014, included passive house window manufacturer Optiwin, airtightness systems provider Isocell, and external insulation supplier Baumit. According to Conor Ryan of Optiwin, the events offer an invaluable opportunity to help upskill the UK market in robust low energy building. "We look forward to continuing bespoke CPD events in 2015," he said.

For further information on the Advantage Austria events please contact Peter Franklin at Advantage Austria at london@advantageaustria.org
For information on Optiwin's 2015 CPD events contact conor@optiwinuk.co.uk

Pictured at the Advantage Austria workshop in Edinburgh in October are (top, l-r) Baumit UK MD Alan Haugh; Isocell's UK operations director Stuart Prouse; Optiwin head of UK operations Conor Ryan; award-winning passive house architect Kirsty Maguire; and Advantage Austria's marketing officer Peter Franklin

# News

## Soltherm chosen to externally insulate exposed Welsh properties

Over 300 houses in the villages of Carmel and Y Fron, in North Wales, are currently being insulated using the Solix Soltherm HD Weather external wall insulation system as a part of a wider retrofit programme. The project is being carried out under phase two of the Welsh government's Arbed energy efficiency programme, which is being delivered by contractor Willmott Dixon in north and mid Wales.

Waldemar Malec of Solix told Passive House Plus that while most external insulation systems are not applied during the winter, because they require dry conditions, Soltherm HD Weather was developed for the British and Irish climates and is suitable for application even in damp weather. He said that the sites at Carmel and Y Fron are a case in point, as they are highly exposed to the elements.

"It dries by chemical reaction rather than evaporation," Malec said of Soltherm, "and is wash-off resistant within a few hours." Soltherm EWI systems are cold bridge free and can be applied below the DPC level, Malex added. Soltherm, an EPS system, was also recently used to insulate 130 properties in the Welsh village of Llandysul for Ceredigion County Council, another Arbed project.

Malec believes the benefits of external insulation over internal insulation are still not as widely know as they should be — not only in terms of cold bridging, but as regards moving the dew point towards the outside of the wall build up, unlike internal insulation, which in certain circumstances can move the dew point to the space between the insulation and the original wall. He also pointed out that, by reducing internal floor area, internal insulation can cut tens of thousands of pounds off the value of a home.

Malec said that all Soltherm systems are protected from the typical fungi, mosses and algaes that can grow in the UK & Ireland. Solix has also just launched Soltherm HD Ultimate, an impact-resistant external insulation system that can withstand over 120 joules of force. "It offers higher strength than a brick wall," Malec said. Soltherm is supplied through different distributors throughout the UK & Ireland, with Solix providing training, technical support and site supervision.

(above & below) The Soltherm external insulation system was applied to 130 homes in the Welsh village of Llandysul

## Poor design & install threaten HRV market — ProAir

Galway-based heat recovery ventilation manufacturer ProAir has warned that poor quality design and installation poses a threat to the HRV market in Ireland and the UK. The company's David McHugh told Passive House Plus that a lack of quality standards mean systems are being improperly specified, designed and installed. He said ProAir had been asked to advise on a number of buildings where these issues had led to inadequate ventilation, causing condensation and mould.

"Quite a lot of print space has been allocated to the common concepts attached to low energy construction such as insulation, draught-proofing and the elimination of cold bridges, but relatively little has been written on the other essential component, heat recovery ventilation," he said.

"In particular, HRV design and installation. The British building regulations Part F stipulates that all systems must be commissioned and the results furnished to building control. Because of this, the Building Research Establishment have published recommendations on commissioning these systems, which indeed make sense, but it is impossible to commission systems that have been improperly designed, specified and installed," he said.

McHugh said that while EN standards do exist on the methodology for testing HRV systems, there are no standards on the proper specification of these systems, or on suitable ducting systems.

McHugh said one common issue is HRV ducting being installed outside a building's thermal envelope. "All supply and return ducting should be in a service cavity within the insulation and airtightness envelope of the building. At a minimum, the ducting should be at least within the insulation envelope."

McHugh said that, post building boom, stories of poor HRV jobs emerge every day, and this is threatening the wider reputation of the sector — including for quality suppliers and installers. He suggested a national industry body could produce guidelines on the design, specification and installation of HRV systems and ducting.

"These guidelines need to be backed up by research and solid experience. Maybe this is where [a state body] needs to step in and fund this independent research, perhaps through masters programmes," he said.

"HRV has been proven to work and properly designed and installed systems can deliver contented customers and energy bill savings."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# How to close the performance gap

*The gap between designed and real-life energy performance in new dwellings is a significant threat to the UK's plans to deliver zero carbon homes. Architect **Tom Dollard** describes research by the Zero Carbon Hub to better understand this performance gap — and how to fix it.*

The Zero Carbon Hub's recent work with industry has found extensive evidence of a considerable 'performance gap' between the energy use of new homes as-designed and the actual use of the completed building. This gap occurs when a home requires more energy than was predicted during its design, before taking into account the behaviour of occupants.

This gap represents a significant risk to the UK's carbon reduction commitments. It has the potential to result in higher than expected household energy bills, undermining buyer confidence in new (low carbon) homes. As we approach the zero carbon homes target of 2016, housebuilders are producing higher performing homes and need to be confident that they perform as intended.

> "The industry needs to embed energy literacy across the sector"

Since January 2013, the Zero Carbon Hub has carried out an extensive study that involved over 160 experts and 21 live house building sites across the UK. This project forms the initial phase of industry activity to address the performance gap, the ultimate aim being that by 2020 a minimum of 90% of all new homes meet or perform better than their design.

At the start of the research there was a misconception that the performance gap was simply caused by inaccuracies within energy modelling software and poor construction practice on site. The evidence review report showed that a gap can arise due to issues at various stages of the building process. Throughout this practice, a number of cross-cutting themes keep recurring: unclear allocation of responsibility; poor communication of information; and a lack of understanding, knowledge and skills.

As part of the wider research, a house building process review was developed and undertaken throughout 2013 - 2014, which included detailed analysis of over 200 plots across 21 sites of different sizes throughout the UK. Two multi-disciplinary teams led by industry experts (including myself) spent a week analysing each site, comprising: project team interviews, a construction site walkthrough, a design review and SAP audits. This process was then supplemented on a number of sites with on-site testing using thermography and air-testing across a selection of the plots.

The site inspections analysed several hundred elements of the buildings at all stages of construction. Any deviations from the design were fully documented with good and poor practice noted, and graded in terms of impact on as-built performance. The energy performance was then analysed using SAP and site findings to ascertain the gap in terms of $KgCO_2/m^2$ (% improvement over dwelling emission rate). This could be compared to the original SAP and energy performance certificate (EPC).

The review has identified 15 priority issues that require action to begin to address the performance gap. These include: planners failing to understand the energy challenges, current material and product testing protocols not reflecting 'real world' dynamic conditions when calculating thermal performance, procurement teams failing to consider energy related site skills when reviewing tenders, and site managers considering energy related issues as a comparatively low priority during their quality checks.

For the house building industry, research and development is needed to create innovative and commercially viable methods to test and measure the energy use of completed homes, so that industry can understand their true performance. The industry also needs to embed energy literacy across the sector, with all professionals and operatives undertaking energy training and upskilling. As a result of the project, the government has indicated it is keen to work with industry to develop a new construction details scheme which will be set up to provide assured, as-built energy performance for the most common major building fabric elements and junctions.

In place of immediate additional regulation, the government must clearly indicate that it expects the construction industry to act now to ensure that the performance gap is being addressed; industry must then commit to demonstrating that this has been achieved by 2020. The compliance regime needs to be strengthened, with a number of refinements to energy modelling and verification procedures. Lastly, the government should stipulate that only energy-certified operatives and professionals be employed on public land developments from 2017, which would accelerate demand for industry developed qualification schemes.

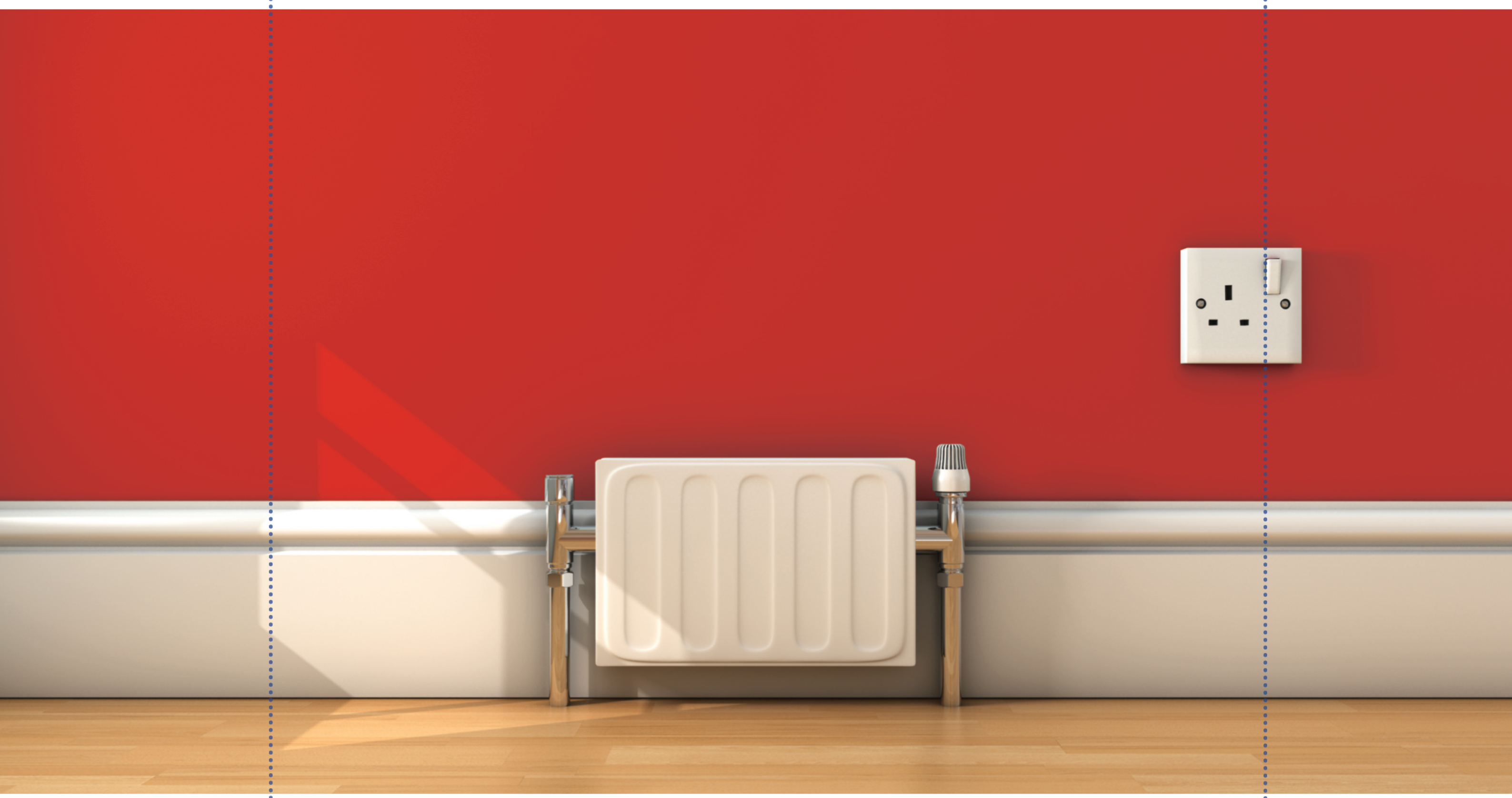
While the project did not specifically look at the benefits of the passive house methodology, the principles can play a part in reducing the performance gap. The site inspections and interviews have witnessed good practice stemming from the passive house standard, and some of this has fed into the recommendations for industry and government. However at a larger scale, passive house projects still suffer the same issues and demonstrate a significant performance gap.

Common problems are found at ground floor and foundation junctions, where insulation is inconsistent or missing and significant thermal bridging occurs. Other areas causing deviation from the design are poor installation of insulation, incorrect window performance, optimistic U-values/Psi-values and unaccounted thermal bridging. Site inspections may not pick up on optimistic product performance, site installation factors such as rain soaked insulation, hidden thermal bridges, site tolerances, level thresholds, or window performance and installation.

The passive house methodology can assist in helping to reduce the performance gap with early stage consideration of energy performance and robust compliance and commissioning procedures. Site inspections are also crucial to delivery on site, but this is difficult to ensure on a larger scale without significant extra resources. It has proven successful on small sites of less than 20-30 units, but gets harder on larger sites with hundreds of workers and more units to be monitored. In Belgium and other parts of Europe, passive house has been delivered on a large scale with the help of offsite construction, but the UK industry currently has very different priorities and procurement methods.

With the completion of the end of term report, the proposals are now moving forwards, to 2020 and beyond. If you would like more information on Zero Carbon Hub's current projects, or if you have further evidence or projects that could be included in the research on the performance gap, please get in touch and sign up to the newsletter at www.zerocarbonhub.org

*Tom Dollard is head of sustainable design at Pollard Thomas Edwards. He leads a research team which inspected 21 sites for the Zero Carbon Hub performance gap report throughout 2013-2014.*







# INTERNATIONAL SELECTION

This issue's selection features ultra low energy buildings from Mexico, Germany, New Zealand and Italy, and illustrates how widely the energy efficiency specification can vary in different climate zones.

## Taller Passive House, Mexico City

Photos: Moritz Bernoully

Mexico's first certified passive house is the retrofit of a roof-top apartment in the country's capital. This small space was originally built cheaply in 2007, mostly with plywood.

But while living in Germany, Mexican architect Alejandro Herrera trained in the principles of energy efficient building. When he returned to his homeland in 2011, he decided to upgrade the apartment — his home — to the passive house standard. Herrera led the project along with Maris Igea, his partner at Inhab Sustainable Architecture.

One of the biggest challenges for the architects was the lack of a passive house supply chain, in terms of skills or products, in Mexico. Contractors had to be trained in passive house principles, while experts travelled from overseas to advise on the build.

But in some ways, meeting the passive house standard was easier in the warm Mexican climate. The apartment achieves a space heating demand of 15 kWh/$m^2$/yr with double-glazing, with wall, roof and floor U-values of between 0.3 and 0.4. Heat recovery ventilation was not required either, just simple mechanical extract ventilation.

The team insulated the entire building envelope with EPS, and airtightness is provided by the OSB along with Siga tapes and membranes. Now, a single electric heater is enough to heat the whole apartment.

The architects say: "A lot of collaborative work took place, it involved a big effort and a deep commitment, and it was all worth it." The finished building is not just the first certified passive house building in Mexico, it's also the first certified passive residential building in all of Latin America. ▶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## Day care building, Georg-August-University, Germany

Photos: Jochen Stüber, Hamburg & Olaf Baumann, Hanover

Completed in 2010, this day centre for Göttingen University was designed by Despang Architekten, who describe it as a "hybrid of landscape and architecture". The building's north and west facades are earth-bermed, but the south facade forms a passive solar curtain-wall with views to the outdoor playground and landscaping. This glazed facade is comprised of a timber-aluminium post-and-beam structure with extensive triple-glazing.

The walls and ceilings were constructed from large, prefabricated concrete elements to minimise the number of joints. The walls were externally insulated and the building is topped with a green roof, while the earth-bermed surfaces help to reduce energy loss, too. The building achieved an airtightness result of 0.43 ACH, comfortably within the target for passive buildings, and has a space heating demand of 15 kWh/m$^2$/yr.

The material palette inside — concrete, glass, spruce wood, linoleum — was in part chosen to avoid off-gassing materials, and the concrete finishes are extended outside the building via thermally broken concrete frames.

These external concrete elements are functional too: they provide seating at their bases, guard rails for the roof, and static shading. The concrete frames also contain dynamic shades which can be pulled down in summer to control overheating and glare.

Passive solar gain is the building's main heat source, backed up by the campus-wide district heating and standalone water heaters. During summer nights, the building is flushed with cool air. But when the shades are up in winter, the low sun penetrates deep inside to warm up the thermally massive concrete structure. ▶

## Whanau, Auckland, New Zealand

Photos: Simon Devitt

New Zealand's first certified passive house started out typically enough: architect Darren Jessop was approached by Phillip and Carolyn Ivanier, a couple wishing to build their first family home. They wanted a modern open-plan family dwelling, and a degree of separation between the 'adult' and 'child' spaces.

But with the design already settled, and prompted by New Zealand's low building insulation standards, the clients made a game-changing request: that the dwelling meet the passive house standard.

The windows were minimised on the south side of the home — where they would lose heat in the southern hemisphere — and overhangs were extended over the north-facing glass to prevent overheating.

The roof and double-stud walls of this split-level timber frame house are insulated with glasswool, but in the subtropical climate of Auckland, respective U-values of 0.37 and 0.23 were enough to meet the passive house standard, as were double-glazed windows. Below ground level, the basement walls are of insulated concrete formwork. Meanwhile the airtight wrap of the house is provided by a Proclima Intello vapour membrane.

Ventilation is provided by a Zehnder heat recovery ventilation system, while an air source heat pump delivers hot water. The house also has rainwater collection and solar photovoltaics.

On completion of the project, Jessop estimated that meeting the passive house standard adds around 10 to 12% to build costs in New Zealand. But he says the occupiers will recoup much more than this amount if they live in the house over its lifetime — while enjoying a warm, comfortable, healthy home. ▶

Image: Ken Nguyen

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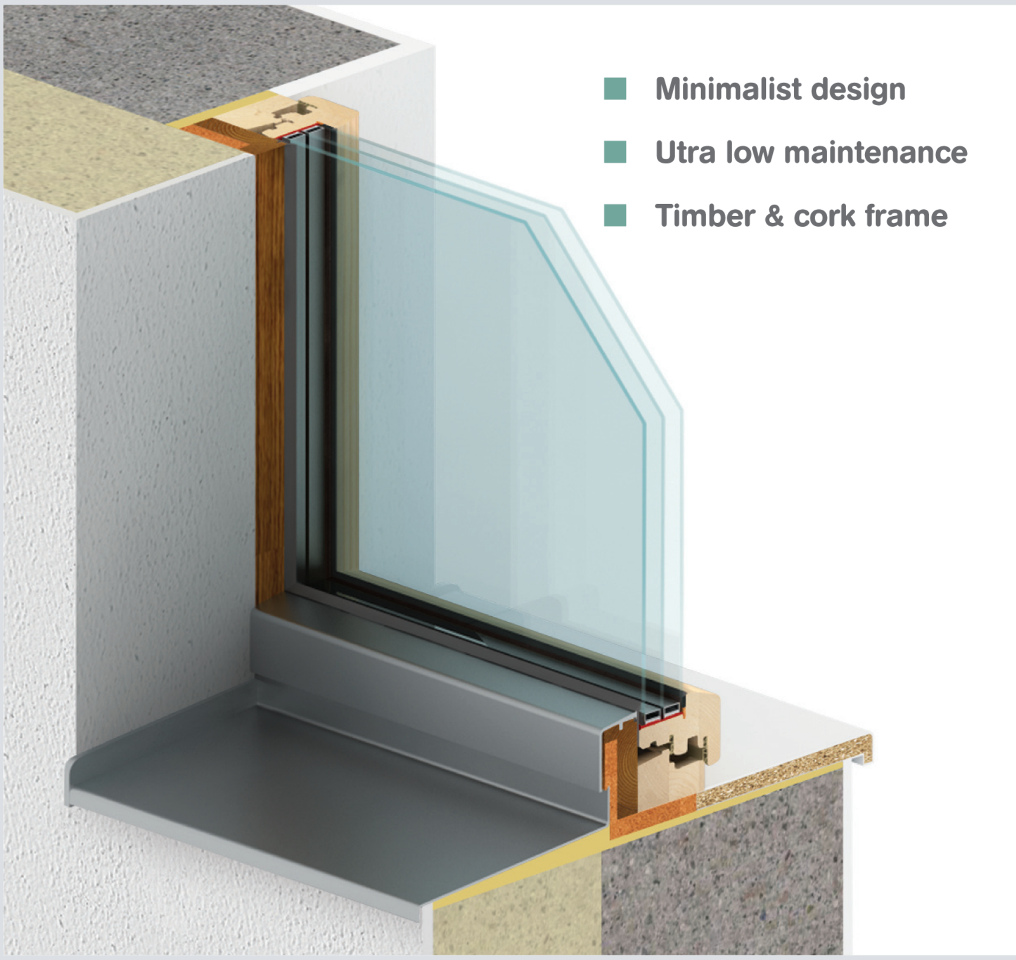

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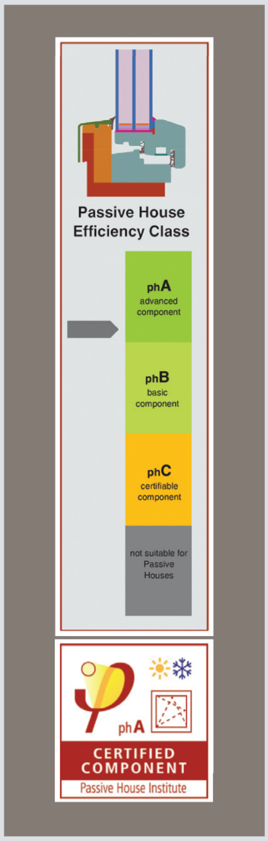


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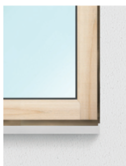

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## Passive House Pichler, Pfitsch, Italy

Photos: Arthur Pichler

This striking certified passive house in the Italian Alps was designed by architects Arthur Pichler and Walter Colombi. The brief was to design a sustainable, open-plan building with ultra low energy consumption.

The top floor of the building contains a single flat with its own entrance — made possible by the sloping site — while the two-storey flat below leads directly onto the garden. In winter, the glazed south facade acts as a "solar stove", the architects say, to deliver passive solar heating. Orienting the building to the south shelters it from the harsh northerly alpine winds too. ▶

Passive solar gain and heat recovery ventilation are the main sources of space heating. There is also a small Windhager wood pellet boiler that provides hot water, and can deliver heat through the ventilation system in the coldest weather.

The timber frame walls and roof are insulated with Thermohemp, while the floor has a meaty 420mm of extruded polystyrene insulation. The building's annual heat demand is just 9 kWh/m$^2$/yr, well inside the passive house mark of 15, and airtightness is 0.4 air changes per hour. Passive House Pichler also has a green roof that helps to keep it warm in winter and cool in summer — and soaks up rainwater too.

And as one of its architects, Arthur Pichler had special motivation to get the house right: he lives on the lower floors with his young family, while his parents live upstairs.

## Want to know more?

**Click here to view additional information on these projects, including an online gallery featuring illustrations, photographs, and project overview panels.**

***This content is exclusively available to our digital subscribers.***

# Passive fishermen’s cottages *on Norfolk coast*

Three award-winning affordable homes in scenic North Norfolk have achieved passive certification while embracing a unique local style of architecture.

**Words: Chris Parsons, Parsons + Whittley Architects**

The beautiful and unspoilt North Norfolk coast provides a haven for visitors, not just in the

Photos: Debbie Harris

summer months when the population swells dramatically, but also out of season for those seeking a tranquil idyll or perhaps enjoying the ornithological diversity that the area provides. This in turn has led to a thriving second home community, which has had the unfortunate effect of making affordable housing for local people very difficult to find. It was this background that led Hastoe Housing Association, in conjunction with the parish council, to bring forward a scheme for much needed local affordable housing in 2007.

A suitable site was provided by the local parochial church council on the western edge of the village on the main approach road into the settlement. Being in a designated Area of Outstanding Natural Beauty and within a local conservation area meant that the design quality of the scheme had to be exemplary. A context study and careful consideration of local materials drove a scheme that also needed to take account of views into and out of the settlement. Planning consent was eventually granted in 2009 although legal matters prevented the scheme from getting underway until 2013.

By then Hastoe Housing were specialists in the delivery of passive house, having delivered the award winning Wimbish affordable housing scheme in 2010 and the subsequent Ditchingham passive house scheme. So it was no surprise when instructions were received to develop the scheme to the passive house standard, despite the fact that planning had already been gained for something much less ambitious. Hastoe expound passive house mainly because it is highly effective at relieving fuel poverty, a huge problem in their sector. They also find that passive house delivers other advantages such as fewer void periods and less ongoing maintenance, while keeping operational energy and the resultant carbon emissions low.

As architects for all of Hastoe's earlier passive house schemes, Parsons & Whittley were unfazed by the challenge, but the timescales required meant that planning amendments had to be kept to a minimum. We were fortunate to have a planning authority who understood passive house, and who were keen to work with us to deliver the scheme while maintaining the design quality. We had modelled the original scheme on the traditional vernacular of fishermen's cottages, and those guys knew a thing or two about working with the elements. We already had a compact form and good south orientation, with very well sheltered, minimal north facing windows.

So the biggest challenge at Burnham Overy Staithe was to take a scheme that had considerable design constraints already imposed, that had not been designed as passive house, and deliver it to one of the most exacting energy efficiency standards.

A quick review of the site identified that while the terrace houses could be adapted to the passive house standard, the three remaining units had a poor orientation and form factor and were unlikely to achieve the passive house standard cost-effectively. Consequently it was decided to concentrate the passive house approach only on the three two-bed terraced units (comprising a total of 228 square metres of gross internal floor area). All of the affordable properties, including the passive house units, needed to achieve Code for Sustainable Homes level four.

First on the checklist was wall thickness. Taking the scheme from 300mm walls to 500mm grew the footprint. Similarly roof insulation and space for ductwork was always going to push the roof higher. The terraced homes had certain aspects in their favour though, such as the compact form (a terrace of three units will tend to have a good form factor, or area to volume ratio), the orientation, and the window arrangement, which needed almost no change.

The use of brick/flint faced walls under a clay pantile roof was fixed, and of course necessary given the sensitivity of the site, so cavities were expanded to take a full 300mm of insulation. Despite its coastal location, the site is relatively well sheltered for a full cavity fill. The foundation became a raft type slab to accommodate additional insulation, although supporting a 200mm flint and block outer leaf without a thermal bridge led to some interesting discussions with the engineers, eventually resolved through the use of an independent strip footing supporting the outer leaf.

Interestingly, the additional wall thickness helped to bring the eaves height down despite raising the roof to accommodate the MVHR ductwork and service voids. The use of thinner PIR insulation at the eaves helped avoid the otherwise typical thermal bridge so often found at eaves details.

The thicker external skin, particularly where faced with local flint, helped to recess the windows to provide shade and a better thermal performance, while actually enhancing the definition of the fenestration. Segmental arches utilised precast concrete or self-supporting arches and the wider frame of the passive house windows kept this detail looking neat. Munster Joinery triple-glazed timber windows provided the necessary glazing performance while retaining a traditional appearance.

Taking the lead from the external finishes, the construction generally followed a masonry approach, for the advantages of thermal mass but also because the skills and materials are freely available. In addition, wet plaster provides an ideal airtightness membrane, leaving the consideration of this aspect down to just the critical junctions and the use of a membrane arrangement on the underside of the roof trusses.

Another limitation of the pre-fixed design centred on the space available for the mechanical infrastructure. Rural exception sites such as these rarely have ideal fuel supplies, and choices were limited in this case. Initially the scheme had been designed to consider community biomass, with a separate outbuilding on site to house the equipment. But fuel supply concerns and a more detailed consideration of carbon emissions from biofuels led to this being discounted. Eventually Genvex 185L compact units comprising an MVHR and exhaust air heat pump were chosen, giving the additional advantage of economy of space. They are positioned on the first floor of each house and the MVHR inlet and exhaust pass through the roof, with supply and extract fitting within a compact service void just below the trusses, or within the space of the metal web floor joists.

Normally a passive house might benefit from a deep roof overhang to provide summer shading, but once again the pre-fixed design prohibited this, so a cooling strategy was developed which included a sensible window opening allowance along with external blinds on the larger south facing glazed areas.

The project was tendered during the early summer of 2013 once the design was fully complete, (to RIBA work stage F), whereupon a local builder, EN Suiter, was successful and started work straight away. The contractor's approach formed an essential part of the success of the scheme, with an openness and willingness to learn and consider the importance and sensitivity of elements that are normally taken for granted. The site quality demands ▶

(top left) the raft foundation which was insulated with 400mm Styrofoam XPS insulation; (middle left) the cavity walls were insulated with Isover Hi-Cav 32 glass mineral wool insulation and clad with brick, while Cavalok BigBlok insulated cavity closers and Ancon Teplo Tie basalt wall ties eliminate thermal bridging; (bottom left) airtightness measures included the installation of a Pro Clima Intello membrane and a suspended ceiling system to house ductwork; (above) the three terraced homes all obtained passive house certification in June 2014; (p33) (top) it was decided not to aim for the passive standard with the other three units at the site, as they had a poor orientation and form factor; (middle) Munster Joinery Eco-Clad timber aluclad windows provided the necessary performance while retaining a traditional appearance

of passive house were recognised and embraced, making the delivery of this exacting standard much easier. Coordination between design and site team continued throughout the build and ensured that milestones were passed without difficulty. The required airtightness of less than 0.6 air changes was achieved at the first attempt and the site was completed and ready to occupy in February 2014.

## Hastoe expound passive house mainly because it is highly effective at relieving fuel poverty

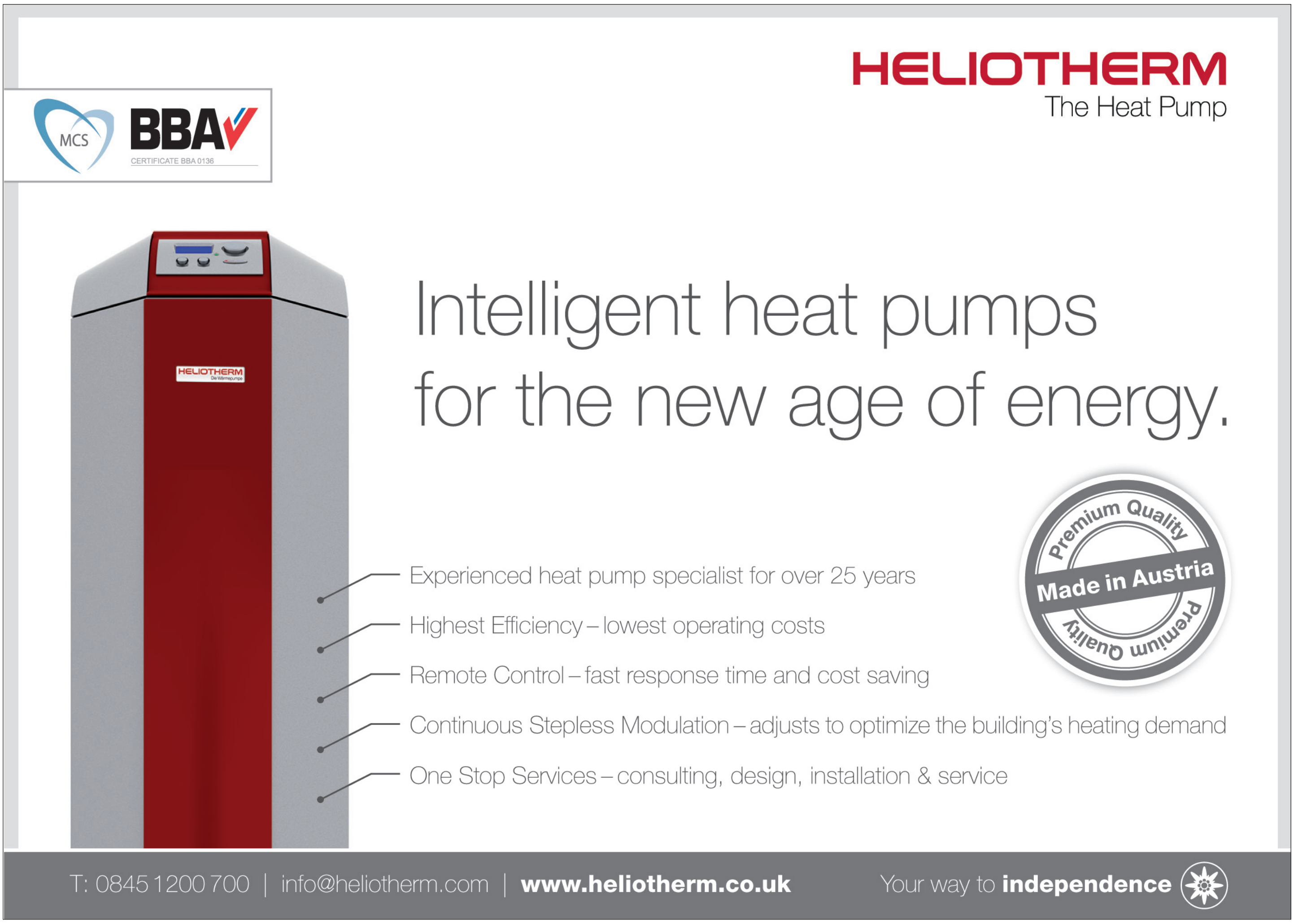
One of the lessons learned from Hastoe's previous schemes is how to hand over something as innovative as passive housing to ensure that occupants get the most out of the dwellings. At Burnham Overy Staithe this was achieved through the production of a small and simple plain English operation guide included in the home owner's manual.

On move-in day the dwellings were set up and working so that the new occupants could concentrate on all the other stressful events that moving house entails. Then a couple of weeks after moving in, when the excitement of the move had subsided, Hastoe and the architects returned and spent an hour or so with each family taking them through the controls and the heating and cooling strategy. One of the most important aspects here is to ensure that occupants experience the controls themselves and get to play with them while experts are around to guide and assist. This process is then repeated at the change of season to ensure the differences between heating and cooling a passive house are well understood.

At the same time as the handover, monitors were installed with the occupants' consent, to measure temperature, relative humidity and $CO_2$. Early data shows that the houses are working to the passive house design intent, with space heating running at just under 9 W/m².

Passive house certification was obtained in June 2014. The overall cost of £1,745 per square metre includes the contractor's overheads, significant external works and professional fees. The actual cost of the buildings themselves comes out at around £1,022 per square metre, which, given the additional material and design quality necessary in this location, represents a cost-effective delivery of the passive house standard.

The project has been well received by locals and passive house enthusiasts alike, and was this year's winner in the UK Passivhaus Awards architectural design category. Most importantly, the Burnham Overy Staithe passive houses demonstrate that this most demanding of energy ▸



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## PROJECT OVERVIEW:

**Building type:** Terrace of three 76 sqm passive two-bedroom homes (the wider development included three further units).

**Location:** Burnham Overy Staithe, on the North Norfolk Coast, in an Area of Outstanding Natural Beauty

**Completion date:** Feb 2014

**Budget:** Part of a larger scheme totalling £980k. Actual build cost £1,022 per sqm excluding preliminaries, externals and fees

**Passive house certification:** Certified

**Space heating demand (PHPP):** 14 kWh/m$^2$/yr

**Heat load (PHPP):** 9 W/m$^2$

**Primary energy demand (PHPP):** 108 kWh/m$^2$/yr

**Environmental assessment method:** Code for Sustainable Homes Level 4

**Other standards & awards:** The houses also deliver against the Homes and Communities Agency's housing quality indicators, while complying with the Joseph Rowntree Lifetime Homes standard and achieving 14 points under CABE's Building for Life standard.

**Airtightness (at 50 Pascals):** 0.60 ACH

**Energy performance certificate (EPC):** Pending

**Measured energy consumption:** 12 months not available but four months shows 8.72 W/m$^2$ heat load

**Thermal bridging:** Thermal bridging generally eliminated. Worst-case 0.1 psi value employed for the full length of the party wall, and for the Helifix stainless steel fixings used for the small area of timber boarding between the windows. Cavalok BigBlok insulated cavity closers and Ancon Teplo Tie basalt wall ties also used.

**Ground floor:** Raft foundation with 400mm Styrofoam XPS insulation. U-value: 0.078

**Brick-clad walls:** 100mm facing brick (or 200mm flint/backing block) external leaf, followed behind by 300mm cavity fully filled with Isover Hi-Cav 32 glass mineral wool, 100mm dense block inner leaf and Gypsum Hardwall plaster internally for airtightness. U-value: 0.096

**Timber clad walls:** 13mm plaster; 100mm blockwork; 200mm Isover Hi-Cav insulation; 100mm Kingspan Kooltherm K5 insulation; 38mm battens/cavity; 19mm timber boards. U-value: 0.104

**Main roof:** Tiles and wind-tight space on 400mm Crown Loft Roll 40, followed underneath by 100mm Crown Loft Roll 40 between bottom chords of truss, 13mm OSB, Pro Clima Intello membrane, 120mm airspace/service void, Gyproc wallboard. U-Value: 0.079

**Pitched roof, sloping ceilings:** 12.5mm Gyproc Wallboard Duplex; 300mm Kingspan Kooltherm K7; 18mm OSB; membrane; battens; tiles. U-value = 0.079

**Windows & doors:** Munster Joinery EcoClad 120 triple-glazed timber windows with aluminium cladding. Warm edge spacers, low-e glass and dual seal for airtightness. Passive House Institute certified. Installed window U-value: 0.85 (as per PHI certificate). Also Munster Joinery EcoClad doors.

**Heating & ventilation system:** Genvex Combi 185L unit. Passive House Institute certified. Combines heat recovery ventilation with an air-to-water heat pump.

and comfort standards need not be compromised by architectural constraints and can be delivered in a wide range of traditional idioms.

SELECTED PROJECT DETAILS
**Client:** Hastoe Housing Association
**Architect:** Parsons & Whittley
**Contractor:** EN Suiter & Sons
**Project manager:** Aecom
**M&E designers:** Engineering Services Consultancy
**Civil & structural engineering:** Rossi Long
**Passive house certification:** Mead Energy & Architectural Design
**Heating & ventilation system:** Total Home Environment
**Electrical services:** Alpha Electrical
**Windows:** Munster Joinery
**Wall ties:** Ancon
**Cavity closers:** Cavalok
**Stainless steel fixings:** Helifix
**Mineral wool insulation (cavity wall):** Isover
**Mineral wool insulation (roof):** Knauf
**XPS insulation (floor):** Dow
**Plaster (for airtightness) & wallboard:** Gypsum
**Airtightness products:** Pro Clima
**Airtight window tapes:** Iso Chemie
**MVHR / heat pump:** Genvex

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# Ledbury passive house

## *embraces warmth, wood & light*

For Ruth Busbridge and her builder Mike Whitfield, aiming for the passive house standard was just one part of an environmentally conscious approach that put natural, healthy materials to the fore.

**Words: Kate de Selincourt**

Entering Ruth Busbridge's light, warm house in the suburbs of Ledbury, Herefordshire, you immediately leave the humdrum mix of post-war semis and 70s infill behind. You have clearly entered an alternative space. Drying fruit and herb teas line the shelves, there are warm natural materials, colourful hand-made textiles, and an altogether welcoming, 'eco' feel.

The style of the house inside and out is recognisable as what Ruth calls 'modern organic' – white paint and render, and natural wood for cladding, window frames, work surfaces, doors and stairs. The carpentry is beautifully finished, with charming bespoke touches: hand-shaped wooden door handles and latches, 'wobbly' cleft oak balustrading, and a secret sliding cupboard under the stairs – all crafted by builder Mike Whitfield and his team.

Not everyone expects a passive house to be like this – and indeed, when Ruth first heard of passive house, she didn't think it was right for her. "When I first heard about passive house, my initial reaction was 'eurgh – I wouldn't want to live in a hermetically sealed house'," she says.

However, that was before she had learned much about it. "I'd been planning to build a house for four years, so I did a course at Cat [the Centre for Alternative Technology in Wales], and I joined the local AECB [the Association for Environment Conscious Building], which is how I met Mike, and passive house was just filtering in. Then I went on a study tour to Germany and became more interested in passive house. The more I heard, the more I thought it made sense."

Mike Whitfield has been building beautiful, environmentally conscious buildings from natural materials for decades – he was the contractor on the conversion of a derelict barn on the Duchy of Cornwall's Herefordshire estate into the new HQ for Architype West, for example. As a main contractor, Mike Whitfield offered Ruth the ideal approach, with his preference for natural and low-impact materials, combined with excellent energy performance, in a style she was drawn to. "I had seen some of his work before. It was beautifully finished, and I prefer the natural look."

By the time Ruth approached him, passive house was becoming a valued tool in Mike's mission to construct buildings that are comfortable, healthy and low-impact: "We had been doing energy efficient buildings anyway, and the AECB were developing their silver and gold standards, which were also moving in the same direction," Mike explains. He then started to work on retrofits and extensions with thermal-bridge-free details and passive house technologies such as MVHR.

Ruth told him she wanted a low energy house, but Mike advised spending a bit more and building a passive house. As a technically minded person herself (she is an IT professional), Ruth was not interested in leaving the crucial parts of design and analysis to others, but instead enrolled on a passive house consultant course so she could be fully involved. There she met architect Janet Cotterell of CTT for a second time (they had been on the same course together at CAT), and hired her to produce the drawings for planning, and to work on the early stages of design.

Once planning permission was secured, Janet, who is based in London, was able to hand over to Mike Whitfield. "Mike took on the construction drawings, and took the lead on site. It was a bit of an unusual contract in that respect, but I had seen the work Mike had done, and I thought 'Ruth won't have any problems' – she was so lucky to have him as her contractor," Janet says.

Ruth also found specialist heating and ventilation designers and suppliers through the AECB: "Because of the collaborative atmosphere in the organisation we never felt we were on our own," Ruth recalls. "The expert advice from Alan Clarke and Nick Grant and from Green Building Store, on designing and sizing the heating, hot water and MVHR, and ongoing support with PHPP, were invaluable. I couldn't have done it without them."

This was the first chance Mike had to build to passive house certification, and he was pleased to take on the job because Ruth shared his preference for low impact, natural materials. The timber frame, which Mike built on site, is insulated with cellulose and clad in a mixture of Douglas fir and lime render, and roofed with reclaimed slates. "I would ideally also have liked an alternative to EPS under the floor, but there wasn't really any alternative that was affordable – and the EPS works really well," Ruth adds.

The timber-frame build-up has a breathable construction, becoming more vapour permeable from the inside outwards. This means that if any water does get in to the structure, ▶


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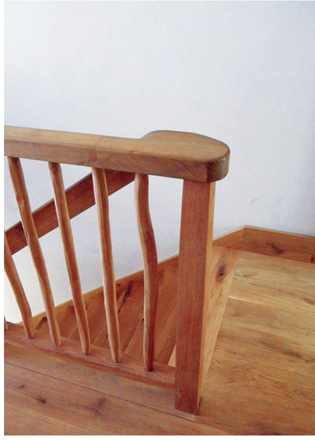

it will dry out. The walls and roof are both insulated with Warmcel cellulose insulation. Mike says: "I have used Warmcel for very many years, we have had our own blowing machine for a long time and have never had problems. After it has been pumped in it packs really densely, almost like cork. It is hard to imagine it settling, for instance."

One of the early design decisions was the size and shape of the house, which is a kind of fat L shape, with a porch. Ruth recalls: "We were also considering a smaller house, but opted for this shape and size [around 130 square metres] so we could have an extra bedroom and bathroom, and so get an income from having lodgers."

As Mike Whitfield points out, this shape is much more involved to build than a simple rectangle: there had to be extra drainage and more junctions, and inevitably it added to the cost. As architect, Janet Cotterell was also keen to keep the form as simple as possible: "Before she settled on passive house, Ruth was considering a more complicated shape – for my part though I would have been happy to make this even simpler. I think a plain rectangle would have looked fine!"

Despite the more complicated form, however, Ruth observes that making the house bigger did make it easier to meet the passive house standard. She adds: "I was very clear I wanted lots of daylight, and light from two sides in every room, which means not all the windows lead to net heat gain. We also have the upstairs ceilings going up into the roof, which does add to the heated volume and heat loss area. So to ensure the passive house standard was met, we have 400mm of insulation in the walls – and the building also had to be extremely airtight."

The original plan was for the OSB to form the airtight layer in the walls, but a preliminary blower door test revealed the board was not quite as airtight as hoped. "So I decided we should go for belt and braces with an additional membrane over the walls," Ruth says. By that stage the internal walls were already up, and adding a membrane to the roof would have been been tricky, so the OSB still forms the air barrier here.

Ruth says: "I don't know if we really needed this additional membrane [in the walls] but I didn't want to risk not getting it certified. In the end our result was 0.24 so perhaps it paid off. Mike reckons we could easily have got 0.2 if we'd remembered to seal the shower trap when doing the final test!"

Planning rules meant the house had to face the same way as others on the street, so it does not have a direct south-facing facade. The off-due-south angle means all glazing has east or west elements, which makes it a bit harder to control overheating.

Looking back Ruth wonders if perhaps smaller windows would have made the design easier. "I think I would still have had ample daylight, but it would have been cheaper, and with less heat loss in winter and less unwanted gain in summer." Though vast windows seem to be de rigeur in some higher-end self-builds, Ruth does not feel they are necessary. "You don't want to live in a goldfish bowl, do you?"

Like pretty much all passive buildings the house is beautifully quiet – you completely forget about the busy road outside, which is something Ruth really values. "It's so peaceful in here," she says. Ruth named the house Wahroonga after a suburb in Sydney where she once lived. "We liked the sound of the name, but we were certain it was perfect when we looked up the meaning of the aboriginal word — it means 'home'."

Ledbury is quiet at night, but the traffic does become noticeable in the morning in hot weather when windows are opened for night cooling. Ruth would like to fit some summer shading (omitted at the time of building for cost reasons), or perhaps install a skylight at the back for faster purge ventilation, partly so she can keep the windows closed more of the time, and enjoy the tranquillity.

She adds: "A low but acceptable risk of overheating was predicted by PHPP [at 2.5% of the time, well within the limits set in the standard], so I took a calculated risk in not dealing with this at build time. But actually, if, like me, you find 25C uncomfortably warm, I recommend you take any overheating risk seriously from the outset, and mitigate against it."

The house is hitting its energy targets, according to Ruth's careful records, with measured primary energy consumption at 74 KWh/m$^2$/yr (the passive house design target is 120). This is as you would expect in a house with relatively low occupancy – and with mains gas and solar hot water. Energy bills are correspondingly low.

When you ask Mike Whitfield what aspect of this job that he felt was most successful, his immediate response is "the lovely client". Though this might sound flip, it goes to the heart of what Mike has learned over 30 years in construction. "In the end, it's only about the people," he says.

"You just want to be able to enjoy the job. Sometimes the anxiety level of the client is just so high that no matter how good a job you do, there is grief." Ruth agrees: "I couldn't imagine working with any other builder. It was stressful of course, but I loved doing it and would do it again."

Both counsel against trying to work with a team who are not all committed to the same outcome. Mike warns: "If you are intent on doing passive house it's important to find a builder who is up for it properly, plus all the consultants, the architect, everyone. If you are trying to drag anyone along you shouldn't bother. Sometimes I'll get approached by an architect who is not really committed, but they think that if they get me to build it, it can be a passive house. "

Ruth has experienced this too, now that she is putting her passive house training to work for others as a consultant: "People come to me with a design, and say 'can you make this a passive house?' But they don't want to change it of course, so it doesn't work."

Ruth says her favourite aspect of the house isn't any one thing, but the whole atmosphere: "It's just lovely to be in, has such a lovely feel, it's light and spacious. It's comfortable, above all else. Warm, dry, peaceful, draught free – even with a door wide open in mid-winter. What's not to like?"

There is a particular pleasure for passive house owners when the weather is nasty outside. "I love being here in winter, I can sit anywhere, and it's always cosy. When I visit friends and family their homes always seem dark, cold and damp, and I have to bring slippers and thick sweaters!" Even though Ruth opted for the simplicity (and exposed thermal mass) of a concrete floor, it's never cold, she says.

Everyone who visits likes the style, with the hand-crafted details. Ruth feels that the bespoke work that went in to creating her door latches, banister rails and the like has given her something she wouldn't have had with a more hard-edged, 'interiors magazine' style.

Yet, as Mike points out, the sharp and high-tech look isn't easy to pull off. "Architects tend to like the crisp modern contemporary look, and we can do it, but the contemporary thing requires a lot of planning, with tiles cut just so, glass stairs and so on.

"I'd argue that with a more organic approach like ours, you actually get a lot of nice effect for more modest cost. And we find actually people tend to respond well to a bit of natural stuff, ▶


so we prefer the handcrafted finish – people comment most of all on things like the wobbly balustrading, and wooden door handles."

Being able to finish a building like this is particularly satisfying for Mike: "On one hand you could say that is superficial, but the finish is an important part of the house. I think it gives the house soul."

**SELECTED PROJECT DETAILS**
**Client:** Ruth Busbridge
**Architect:** CTT Sustainable Architect
**Contractor:** Mike Whitfield Construction
**M&E Engineer:** Alan Clarke
**Energy consultant:** Elemental Solutions
**Airtightness tester:** Paul Jennings
**Cellulose insulation:** Warmcel, via PYC Insulation
**Sheep wool insulation:** Black Mountain Natural Insulation
**Windows & doors:** Optiwin, via Green Building Store
**Gas boiler:** Remeha
**MVHR:** Paul, via Green Building Store
**Solar thermal:** Llani Solar
**Hot water cylinders:** McDonald Engineers
**Lamps:** Locklamp
**Light fittings:** Colin Chetwood
**Low water fixtures:** Green Building Store
**Green roofing:** Green Roof Options
**Silica paint:** Keim Mineral Paints
**I-beams:** JJI Joists
**Insurance:** Insure Green
**Finance:** Ecology Building Society

## Want to know more?

**Click here to view additional information on these projects, including an online gallery featuring illustrations, photographs, and project overview panels.**

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(below) metal web floor joists enable the HRV ducting to be run discretely through the house, along with pipes and wires; (bottom) the timber frame walls are insulated with Warmcel cellulose insulation but with Natuwool sheep wool insulation at service voids and window reveals and finished with plywood boxes; (above) building contractor Mike Whitfield outside the house as it nears completion

## PROJECT OVERVIEW:

**Building type:** 129 square metre (TFA) detached two-storey timber frame house

**Location:** Ledbury, Herefordshire

**Completion date:** June 2012

**Budget:** £240K

**Passive house certification:** certified

**Space heating demand (PHPP):** 14kWh/m²/yr

**Heat load (PHPP):** 9 W/m²

**Primary energy demand (PHPP):** 79kWh/m²/yr

**Environmental assessment method:** none

**Airtightness (at 50 Pascals):** 0.24ach

**Measured energy consumption:** 74 kWh/m²/yr approx (August 2012 to August 2013. Conversion factors: 11kWh/m³ for 385m³ gas and 2.7 kWh/kWh for 1989kWh electricity)

**Ground floor:** 200mm reinforced concrete slab (raft foundation) insulated with 300mm EPS insulation. U-value: 0.113

**Timber clad walls:** douglas fir horizontal cladding externally, followed inside by 25 x 50mm treated battens, Permaforte membrane, 22mm wood fibre board, 45x45 outer timber frame with Warmcel, 280mm Warmcel cavity with Larsen truss ply gusset, 45 x 95 structural timber frame with Warmcel, 18mm OSB, Pro Clima DB+ vapour check and airtight membrane, 45mm service cavity insulated with Black Mountain Natuwool (sheep wool) insulation, 28mm double plasterboard and skim. U-value: 0.096

**Render clad walls:** lime-based render, 40mm Steico board, 45x45 non-structural timber frame with Warmcel, 300mm Warmcel cavity with Larsen truss ply gusset, 45 x 95 structural timber frame with Warmcel, 18mm OSB, Pro Clima DB+ vapour check and airtight membrane, 45mm service cavity insulated with Black Mountain Natuwool (sheep wool) insulation, 28mm double plasterboard and skim. U-value: 0.089

**Roof:** reclaimed Welsh roof slates externally followed underneath by battening, 22mm Steico board, 45/316/45 timber I-beams with Warmcel, 75mm timber batten with Warmcel, 18mm OSB U-value: 0.085

**Windows:** Optiwin Alphawin alu-clad timber triple-glazed window. Passive House Institute certified installed window U-value: 0.85

**Heating system:** Remeha Avanta gas boiler 18kW with Stelrad radiators. Five square metre Velux solar thermal panels with cylinder: 250L Indirect Powerflow 2000 unvented mains pressure system (split 100L Solar, and 150L Boiler). Microbore hot water pipes throughout.

**Ventilation:** Paul Novus heat recovery ventilation system. Passive House Institute certified to have heat recovery rate of 94.4/93% effective heat recovery rate.

**Green materials:** green roofs on two single-storey extensions. Reclaimed Welsh slates. Cellulose and sheep wool insulation. Keim silica paint, UK grown timber – English oak floorboards, untreated douglas fir cladding, softwood frame. I-beams from JJI Joists (Scotland). Locally made doors and door latches. Locally made light fittings. Low energy lighting throughout (T5 tubes, LEDs, compact fluorescent lights).

# Sleek-and-striking passive house

## graces eco-village

The eco-village at Cloughjordan, Co Tipperary is no stranger to low energy buildings, and with this passive house, architect Paul McNally set out to prove that energy efficiency and good architecture go hand-in-hand.

**Words: Paul McNally, PassivHaus Architecture Company**

For me there was a strong wish with this house to produce a design that would demonstrate that achieving the passive house standard was not an impediment to good architecture. Two years ago, at the Better Building conference in Dublin, one of Ireland's leading educators of young architects argued that great architecture should be exempt from energy efficiency regulations, because having to comply would excessively interfere with the expression of his architecture. It is tragic to think that a great architect believes he cannot accommodate robust detailing within his artistic objective.

We can only counteract this attitude by proving it wrong. I think it is incumbent on clients and designers of passive houses to ensure that only the highest standard of design is achieved in passive buildings. A passive house certificate is not a substitute for good architecture. Sustainable buildings which are aesthetically poor create an example to be used by those who are not inclined to produce low-energy buildings, and want an excuse. Therefore high performance buildings must also be beautiful.

It's interesting to take a look back at the story of this passive house from our current perspective. It's safe to say that we are in a very different place in mid 2014 economically, to where we were when this house was being built in 2009 and 2010. At that stage, the wheels had just fallen off the wagon in the Irish construction sector. It was a frightening time to procure a building. For those of us young enough for it to be our first recession, it brought new challenges that we had never experienced before.

This project was completed in late 2010 and early 2011, and as I reacquaint myself with the project file for the purpose of researching this article, I see that most of the companies and personalities involved are no longer in business. Some got into difficulty during this project, and others have wound up since its completion.

Fiona Nolan, the client and owner of this house, is one of the members of the eco-village at Cloughjordan, Co Tipperary. I met Fiona at the Cultivate sustainability centre in Dublin in 2007, where she attended a planning day for the eco-village members. At the time, I was considering becoming a member myself, and had started attending some events to get a feel for what was being planned. I also took the opportunity to set up a stall at the event describing my professional services. From that event, I was lucky enough to pick up three clients in the eco-village for whom I would go on to design homes. Fiona's is the only one constructed to date, as changing circumstances in those turbulent times prevented the others from going ahead. Fiona was fortunate enough to be able to proceed.

Since setting up my practice in 2004, I have always appreciated the passive house approach to construction, and initially strived unsuccessfully through bad luck and inexperience to take early potentially passive projects to completion. There are many interpretations of what kind of building is most appropriate for addressing the environmental issues facing us. Some people choose to place emphasis on the sourcing of materials, on breathability, natural ventilation, recycled components, local materials and avoiding certain substances, etc. The eco-village has a charter which obliges all members to address these issues and more.

I was fortunate enough to find in Fiona a client who had the intention and means to get this ▸

It's incumbent on clients and designers of passive houses to ensure that only the highest standard of design is achieved in passive buildings. A passive house certificate is not a substitute for good architecture.

project over the line. Fiona and I agreed that energy efficiency was a primary concern and so the brief from day one was to aim for passive house certification if possible, in excess of the standard required in the charter. While the house has not been certified, it can be when the client chooses to, as it has met all the requirements.

The architect Louis Sullivan famously asserted that 'form follows function'. The design for this project emerged from a direct response to the site. I think tight, difficult sites, are actually the easiest to design for, because the difficulties force a pragmatic response. My worst nightmare is to have to design a building for a greenfield, blank canvas site. The literally endless possibilities would make it very tough to decide which way to go. In this case, the requirement to provide southern aspect glazing for heat gain potentially conflicted with the entrance approach, meaning privacy would be an issue. I resolved this by introducing a diagonal screen wall and hiding the living spaces behind it. The curve in plan draws the visitor towards the front door, away from the large window behind the screen wall.

The rest of the plan is generated by the very efficient planning device of creating a central stairwell and circulation space about which all the rooms revolve. The logic of the plan allows the living, dining and kitchen space to enjoy the west aspect, which means evening light and sunsets can be appreciated from here and the master bedroom upstairs, which has an indented balcony.

Incredible attention was paid to giving what appears to be a relatively simple elevation an intrinsic harmony. The principles of the golden section, and the harmonic system of proportion, were used to underpin the setting out and dimensions of the facade. The dotted lines ('traces régulataire' as Le Corbúsier called them) in the elevation show where the golden section or square proportion was used to establish order.

The airtightness layer is the OSB board which has been taped and sealed with mainly Pro Clima tapes. A Solitex membrane was used to give continuity between ground and first floors by wrapping around the first floor cassette. The construction system used was closed-panel timber frame manufactured by sub-contractor A-Frame in Co Meath. This means the walls were insulated in the factory, with Thermo Hemp, a method which gives greater quality control than site-insulated open-panel systems. The insulation is protected from the risk of getting wet also.

The wall cassettes were then clad on-site with Gutex wood fibre insulation externally, which eliminates thermal bridges, and an internal service cavity was further insulated. External render was applied to a vented Aquapanel rainscreen. The roof and balcony construction were similar, with a vented air layer under the waterproof layer again offering a very robust way of dealing with moisture in the construction, which was breathable.

The eco-village has a district heating system, fired by a communal wood chip boiler and backed up with a solar array. The district heating is not working at its optimum yet, as it is designed for the full build-out of the development, which is perhaps just over half occupied at the moment. The system supplies a large thermal store buffer tank in the plant room once or twice a day, from which a heat exchanger draws heat and tops up the heat recovery ventilation system.

On top of the standing charge, the client has reported around €100 per annum heating costs. At the 2013 NZEB (nearly zero energy building) Open Doors event, Fiona noted the house does not overheat, despite omission of the solar shading as a cost-saving measure, and maintains comfortable temperatures without a backup heating system. There are no radiators, although we plumbed a heating circuit in just in case. There was originally intended to be a stove in the living room which was also omitted. I have learned from this and subsequent passive projects to be confident about what you leave out. If your heat load is telling you that you don't need a back-up heating system or central heating, don't put one in.

A word of warning is that while on this project the OSB airtightness layer worked, it hasn't for some other practitioners, so I would recommend you use the new products on the market which give guaranteed results. We have also found that on completion, some clients have found it difficult to obtain competitive house insurance for 'non-standard construction'. Mainstream insurers often deem 'standard' to mean pre-2011 building regulations 100mm cavity construction. This may have changed since the completion of this building, but at the time the client struggled to get quotes and eventually

(from top) installation of the Supergrund insulated foundation system; the 60mm of Gutex Ultratherm external to the Thermo-Hemp insulated, closed-panel timber frame system; a Siga Majpell airtightness and vapour membrane, which was used in places in addition to the principle Pro Clima Intello vapour check; the Aquapanel cement board helps to protect the house from the elements; Thermo-Hemp insulation in the walls

I was fortunate enough to discover Arachas insurance brokers who obtained cover through Hiscox.

This is a project which meets the passive house standard and boasts other significant environmental benefits, not just in terms of construction, but location, community and hopefully you will agree, in terms of architectural merit.

*After ten years of private practice, Paul McNally has announced the launch of a new venture in the field of passive house architectural services. A new architectural practice, The PassivHaus Architecture Company, is now providing services with a particular focus on the commercial sector. This follows on from the recent completion of Paul's passive house pharmacy and apartment project in Clonmel, Co Tipperary which will be the subject of a future article in Passive House Plus.*

**SELECTED PROJECT DETAILS**
**Client:** Fiona Nolan
**Architect:** The PassivHaus Architecture Company
**Timber frame:** A Frame
**Main Contractor:** Breakwater Construction
**Civil & structural engineering:**
Tanner Structural Design
**Quantity Surveyors:** Duffy Quigley
**Airtightness testing:** PK Energy Controls
**Wood fibre & hemp insulation:**
Ecological Building Systems
**Floor insulation:** Kingspan Aerobord
**Airtightness products:** Ecological Building Systems
**Windows and doors:** Optiwin
**Roof windows:** Dublin Glass Company
**Cement board cladding:** Greenspan
**Green cement:** Ecocem
**Building boards:** Fermacell
**Heat recovery ventilation:** Paul
**Flooring:** Forbo
**Roofing:** Gilescourt
**EPDM roof membrane:** Firestone
**Home insurance:** Arachas

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***This content is exclusively available to our digital subscribers.***

## PROJECT OVERVIEW:

**Building type:** 163 sqm detached two-storey timber frame house

**Location:** Cloughordan eco-village, Co Tipperary, Ireland

**Completion date:** August 2011

**Budget:** Not disclosed

**Passive house certification:** Not certified

**Space heating demand (PHPP):** 15 kWh/m²/yr

**Heat load (PHPP):** 12 W/m²

**Primary energy demand (PHPP):** 66.18 kWh/m²/yr

**Airtightness:** 0.5ACH at 50 Pa

**BER:** A3 (71.6 kWh/m²/yr)

**$CO_2$ Emissions Indicator:** 5.26 (kg$CO_2$/m²/yr)

**Thermal bridging:** Thermal bridges were eliminated in the detailing but default values were used in DEAP and PHPP.

**Ground floor:** Supergrund foundation. 300mm expanded polystyrene insulation, 100mm Ecocem concrete slab. U-value: 0.112

**Walls:** Fermacell board internally, followed outside by 50mm Thermo-Hemp insulated service cavity, OSB, 200mm Thermo-Hemp insulated closed panel stud, 60mm Gutex Ultratherm, ventilated cavity, Aquapanel cement board. U-value: 0.14

**Roof:** Fermacell board internally, followed above by 50mm Thermo-Hemp insulated service cavity, Pro Clima Intello vapour check, 250mm Thermo-Hemp insulated joists, OSB, 1000mm Gutex Ultratherm, vented cavity with firring pieces laid to fall, marine ply decking, Firestone EPDM roofing membrane, 100mm river washed pebbles externally. U-value: 0.106

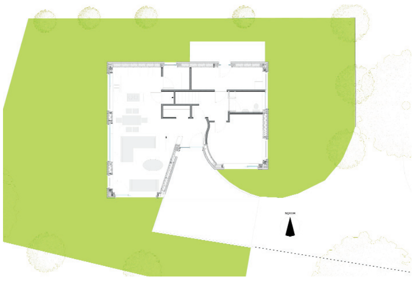
**Windows:** Triple-glazing Passive House Institute certified Optiwin Wood-2-Wood timber windows and entrance doors. Overall installed U-value ranging from 0.72 to 0.89

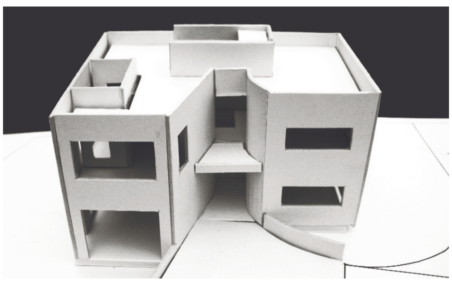
**Roof window:** Triple-glazed roof window with external toughened glazed non-thermal screen. U-value: 0.7

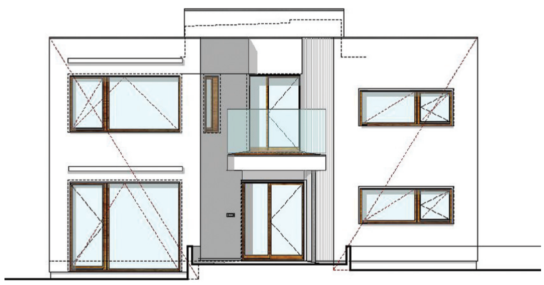
**Heating system:** District heating system supplied by wood pellet power station and communal solar array. Supplies domestic hot water and water to air heat exchanger to ventilation system.

**Ventilation:** Paul Atmos 175DC heat recovery ventilation system. Passive House Institute certified to have a heat recovery rate of 88%.

**Green materials:** Fermacell dry lining board, hemp insulation, Auro natural paint, 50% GGBS cement, LED lighting, EPDM roof membrane, Gutex wood fibre insulation, cement rainscreen rather than blockwork, Marmoleum and timber floors.







# LOW ENERGY TIPPERARY OFFICES GO FOR GOLD

A new development in Tipperary aimed to combine excellent levels of airtightness and insulation with generous glazing and natural ventilation to deliver ultra-modern, comfortable, low energy offices. How did it work out?

**Words: John Hearne**

This site in Tipperary Town is home to decentralised offices for the Department of Justice and Equality, and new civic offices for Tipperary County Council. Arranged in two separate buildings east and west of a central civic plaza, the project is underpinned by a sustainable ethos that can be identified at almost every point in the design process.

Bernie O'Brien is caretaker at the civic offices. He says that the staff are delighted with their new quarters. "My last building was an old period building that was converted for offices," he says, "but it was cold, draughty and hard to heat. It needed a lot of maintenance. This building is state of the art."

District engineer, Aidan Finn, agrees. "They're bright, airy offices," he says, "it's a really pleasant place to work in." Finn, who was town engineer during the build, explains that a committee within the local authority co-ordinated with the Office of Public Works (OPW) to develop a full specification ahead of the tendering process.

The contract was won by a building firm, Stewart, a company which has a long-established track record in sustainable building. The Galway firm built the Bucholz/McEvoy designed SAP offices in Ballybrit, Galway, along with the BREEAM Excellent rated decentralised offices in Roscommon in 2010.

MD Paul Stewart says that the design and build model works well with a sustainable agenda. "You don't get as many design iterations or changes," he says. "It's much easier to drive efficiencies because people know where waste can occur, and they all work together. There's no incentive to do that on traditional build projects."

He points out that since the recession, the tendering process has frequently precipitated a race to the bottom, as contractors sell at or below cost simply to keep going. Because price isn't the sole criterion on design and build projects, there is much greater scope to deliver an optimal solution. It also gives the lifetime costs of the building a priority that can be lost on traditional builds.

Stewart retained Coady Partnership Architects for the project. The two companies had worked together on a number of other buildings, including the aforementioned decentralised offices in Roscommon.

Photos: Donal Murphy

Tomas Sexton, project architect for Coady, explains that the design team employed a collaborative approach. Contractor, architect, structural, civil and M&E engineers, landscape architects and others all came together in a round table format to tease out the various issues.

"We worked all our strategies out early on," says Sexton. "Buildability solutions, structural solutions, we talked with M&E about ventilation strategies, we discussed building width, grid depth, steel versus concrete, precast versus insitu, grid structure, the depth of the plan for light penetration and so on."

The Stewart-Coady partnership had used a poured-on-site concrete slab with columns on the Roscommon project. In Tipperary, they had intended using the same approach, but then realised that by using precast concrete sourced locally, onsite wastage would be cut. "So even at that stage we were looking at supply chain," says Sexton. "We wanted to show the OPW that we could improve on the green credentials of the project, even at that specification level."

The design team sought to preserve as many of the site's natural features as possible. Work exclusion zones were instigated around trees, while archaeology discovered during excavations was preserved and documented. The civil engineers used a natural dip in the terrain to facilitate a drainage solution and avoid the need for attenuation tanks. Swales were created to collect run-off water from car parks, which meant that petrol interceptors were largely unnecessary.

"These kinds of approaches," says Sexton, "allowed the contractor to keep his price down, and at the same time, it demonstrated to the OPW that we were taking a better environmental approach to developing the site."

Paul Stewart says that making a building both aesthetically pleasing and environmentally sound can sometimes be difficult. Extensive glazing is a frequent requirement, both to provide the right look and to deliver daylight into office spaces. "But that isn't necessarily the most environmentally friendly to design or build," he says.

In large office buildings, the cooling load is typically heavier than the heating load, which is why conventional developments invariably require large air conditioning systems. In Tipperary, both buildings are naturally ventilated. The natural ventilation strategy not alone reduced the M&E bills for the project, it also makes both buildings much cheaper to cool.

This system is facilitated by windows at high and low level. The top hung sashes are controlled by the building management system (BMS) linked to temperature and $CO_2$ sensors. These facilitate automated indoor environmental control, night purging and summer cooling. There's also sufficient flexibility for staff to override the ▶

system and open or close windows as they require. It was deemed that only meeting and conference rooms, because of their higher occupancy levels, required mechanical ventilation.

District engineer Aidan Finn says that over the summer months, the Tipperary County Council building maintained an even, comfortable temperature even on the hottest days. "You can manipulate the temperature in each individual room. Some people are colder than others, some people are warmer than others. It's about playing around with that, making sure that you get everything just so."

But he says that the brise soleil fitted to the southern elevation to deal with glare didn't do that job quite as well as had been hoped. Indoor temperatures in the Department of Justice building also rose a bit above comfortable temperatures during the summer heatwave in 2013.

Flexibility was also an integral element of the design. The natural ventilation strategy had to address, not alone the current layout, but also

(clockwise from above) Glazed curtain walling with brise soleil on the Tipperary County Council building; the ground floors were insulated with 80-90mm of high performance insulation boards; construction proceeds at the site; an aerial view of the site, with the Department of Justice building in the foreground; the project won awards for sustainability achievement and public sector project of the year at the 2013 Fit Out Awards; (opposite page) (top) the Tipperary County Council building with brise soleil and (bottom) the main Department of Justice building was insulated and rendered externally with the Solix Soltherm EPS system

the possibility of future layout changes. Tomas Sexton again: "The brief required office spaces to be fully adaptable from cellular to individual and vice versa, so we needed a ventilation strategy that would work for both." Again, in order to provide for future design changes, open spaces were designed with raised floors to facilitate distribution of services.

The use of precast concrete, in addition to delivering a greener supply chain, also allowed the buildings to benefit from thermal mass. "It gave a very high quality finish internally," Sexton adds, "and good reflectance." Because the buildings are naturally ventilated, there was no need for suspended ceilings to contain the ductwork (although many passive houses with stainless steel ductwork shun suspended ceilings, instead expressing the ductwork as part of the architecture). Instead the fair-faced, precast concrete was given an aesthetic finish and left exposed.

Single leaf block fitted with external insulation was deployed throughout the project. "It's easier, quicker and more cost-effective to build," says Sexton. "And by having a good rational structure, you have a better chance of keeping a very high standard. Often if things are overly complex, and very dependent on trades, your quality can drop and the eventual performance of the building can drop."

The external insulation system chosen was Soltherm HD Weather from Solix. "It's specially designed for British and Irish weather," says Waldemar Malec of Soltherm. He explains that the key advantage of the mineral texture coat applied to the insulation system is that it dries by chemical reaction rather than by evaporation, which means that it can be applied during cold and wet months. "The texture coat is wash-off resistant in two hours," he says. "Because of that advantage, we were able to start in December, and deliver the job three months before schedule."

Simplicity and rationality were also central to the decision to rely on wet plastered blockwork internally to deliver airtightness. This was supplemented by tapes and seals at key junctions. The Department of Justice building achieved an airtightness result of 1.73($m^3$/hr)/$m^2$ at 50Pa. While large buildings sometimes hit what seem like comparatively low airtightness results, thanks to their often low surface area to volume ratio, this still seems a strong showing for a building with a natural ventilation strategy demanding over 500 opening sashes, while the Tipperary County Council building achieved 2.64 $m^3$/hr/$m^2$.

"The design team and the contractor realised from an early stage that designing and constructing an integrated building envelope was one of the key contributors of having an energy efficient building," says Brian Shannon of BE Technologies, who advised on the thermal envelope.

The heating solution incorporates a range of Jaga trench and low-water content wall-mounted radiators located throughout both buildings. Andrew Treacy of Versatile, who supplied the units, explains that low-water content radiators deliver heat far more efficiently than conventional radiators by achieving target temperature more quickly. The system is exceptionally responsive. "The system shuts down so quickly in response to free heat sources like solar gain and occupancy," he says, "that you're always staying closer to your heat set point; so you don't have these peaks and troughs."

"My last building was an old period building that was converted for offices, but it was cold, draughty and hard to heat. It needed a lot of maintenance. This building is state of the art."

The roof of Tipperary civic offices has also just been fitted with 45kW of solar PV panels as part of the largest project of this nature in the country. Organised by Tipperary Energy Agency (TEA), fully nine public buildings throughout the county have been kitted out with solar PV arrays totalling 800 panels. TEA estimates that the array on the roof of the civic offices will supply 10% of the building's electricity requirements.

The Department of Justice building has been designed to achieve 'Gold' standard certification under LEED, the US Green Building Council's certification program which takes into account a building's energy use, location and transport, materials and resources, water efficiency and indoor environmental quality. The overall project has also been commended for sustainability by the RIAI, Irish Concrete Society and the Fit Out Awards.

**SELECTED PROJECT DETAILS**
**Client:** Office of Public Works
**Contractor:** Stewart
**Architect:** Coady Partnership Architects
**M & E engineers:** Arup ▶

**Civil & structural engineering:** Tobin Consulting Engineers
**Mechanical contractor:** T Bourke & Company
**Electrical contractor:** Tim Kelly Electrical Contractors
**Airtightness consultant:** Building Envelope Technologies
**Biomass boilers:** Filtrex
**Gas boilers:** Euro Gas / Remeha
**Radiators:** Versatile
**Underfloor heating:** Henco / Unitherm
**Heating controls:** Ace Control Systems
**Solar PV:** Solaregy
**Heat recovery ventilation:** Mitsubishi Electric
**High level opening vents:** Ace Control Systems
**Air conditioning:** Mitsubishi Electric
**Solar thermal & rainwater harvesting:** Kingspan Environmental
**External wall insulation:** Solix
**Additional wall insulation:** Kingspan Insulation
**Roof insulation:** Ballytherm
**Floor insulation:** Xtratherm
**Windows, doors & curtain walling:** Season Master
**Entrance doors:** Boon Edam
**Brise soleils:** QEF
**HPL cladding:** CEP Claddings
**Stone cladding:** StoneTech
**Green cement:** Ecocem

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## PROJECT OVERVIEW:

**Building type:** Two new office buildings, one for the Department of Justice (4,405 sq m), one for Tipperary County Council (1,970 sq m)

**Location:** Tipperary Town, Co Tipperary

**Completion date:** Early 2013

**Building Energy Rating / Display Energy Certificate:** Not yet available. Project constructed to target A3 BER.

**Environmental certification:** The Department of Justice building will be submitted for LEED 'Gold' certification.

**Airtightness (Q50 at 50pa):**
Department of Justice: 1.73(m$^3$/hr)/m$^2$
Tipperary County Council: 2.64 m$^3$/hr/m$^2$

**Floors:** Insulated with 90mm Xtratherm Thin R or 80mm Kingspan K3 Floorboard. U-values: 0.15 & 0.156

**Main roofs:** Single ply membrane externally, followed below by 150mm insulation*, vapour barrier, screed, precast slab: U-value: 0.15

**Single-storey/pop-out roofs:** Single ply membrane externally, followed below by 150mm insulation*, vapour barrier, profiled metal deck. U-value: 0.15

**Rendered (main) walls:** Render, 200mm Soltherm HD Weather platinum EPS system, 215mm blockwork, 16mm wet plaster. U-value: 015

**Timber-clad walls:** Timber weatherboarding, followed inside by 40mm ventilated cavity, breather membrane, 120mm insulation* (foil faced, tape and sealed acting as vapour barrier), 215mm blockwork, 18mm wet plaster. U-value: 0.18

**Stone-clad walls:** 175mm coursed stone, followed inside by 100mm blockwork, 50mm cavity, 100mm insulation*, 215mm blockwork, 18mm wet plaster. U-value: 0.17

**Basalt-clad walls:** 40mm stone cladding on ss fixings 50mm cavity, followed inside by 160mm insulation* (foil faced, tape and sealed acting as vapour barrier), 215mm blockwork, 18mm wet plaster. U-value: 0.2

**HPL-clad walls:** HPL boards on S/W battens followed inside by 40mm ventilated cavity, breather membrane, 40mm insulation, vapour barrier, 18mm WBP plywood, 250mm mineral wool insulation between primary steel structure U-values: 0.15
*Insulations used were high-performance rigid insulation boards from Kingspan, Xtratherm and Ballytherm

**Glazing:** Season Master double-glazed windows, doors & curtain walling, with Carey Glass. Argon fill. U-values: c.1.1

**Heating:**
Tipperary County Council building: Herz Firematic 90kW wood chip and pellet boiler & Rehema 140kW condensing gas boiler.
Department of Justice: 300kW Herz Biomatic 300kW chip/pellet boiler & Eurogas 450kW condensing gas boiler.

Gas boilers were sized to allow for future expansion of the buildings. Heat distributed principally via Jaga Mini Canal trench heaters and Jaga wall-mounted radiators. Kingspan Thermomax HP Vacuum tube solar collectors contribute to domestic hot water.

**Ventilation:** High level opening vents controlled by BMS throughout the building. Mitsubishi Electric Lossnay heat recovery ventilation units to meetings/ conference rooms.

**Electricity generation and use:** 45kW solar photovoltaic array to Tipperary County Council building. All artificial lighting is controlled by automatically dimmable PIR sensors, and low energy lifts were installed.

**Water:** Low water usage appliances and rainwater harvesting for flushing WCs.

**Green materials:** 50% GGBS used in reinforced concrete throughout, and "responsibly sourced" low VOC materials were used.

# From drab farm shed to passive, light-filled studio

When Sjölander da Cruz Architects sought to turn an old abestos-clad shed into the firm's new studio, it offered the perfect opportunity to put an enthusiasm for passive house design into practice.

**Words: Lenny Antonelli**

What better way for an architecture firm to break into passive house design than by creating its own passive-certified architectural studio? Birmingham-based Sjölander da Cruz Architects had bought an old asbetos-clad agricultural shed near Leamington Spa, and planned to retrofit it into the practice's new offices.

"We just wanted to create something that was a comfortable working environment," says project architect Shely Begum. The Sjölander da Cruz team embraced passive house principles from the outset, and aimed for Enerphit certification, the Passive House Institute's retrofit standard.

"This was the first passive house building we worked on," Shely says. "We've always been interested in sustainability. Prior to doing this we had been to quite a few passive house lectures. We felt [passive house] was the future of sustainability, and it was something we wanted to be involved in."

Arden Construction was appointed as contractor — it was their first passive project too — while energy consultant Nick Grant of Elemental Solutions came on board to advise the team.

The existing shed had a north-south orientation, ideal for making the most of passive heat gains. The building is in the green belt, so the existing shape and volume had to remain, but the simple form lent itself to passive design, minimising the external surface area from which heat could escape.

First, a specialist subcontractor removed the asbestos cladding from the old steel frame structure. Some of the steel beams were in a bad state too, and needed refurbishment.

Sjölander da Cruz chose to keep the existing concrete slab, but wanted to construct two internal mezzanines. This meant there was little room to beef up the floor insulation without limiting headroom under the mezzanines, so only 120mm of phenolic insulation was installed on the slab. To reach the Enerphit standard for heating demand, the team now had to push the thermal performance of the walls, roofs and windows even further.

For the walls, the new thermal envelope consists of Kingspan Tek structural insulated panels (SIPs) outside the existing steel frame. The panels consist of urethane insulation sandwiched between two layers of OSB. Sjölander da Cruz has extensive experience with SIPs, so it was the natural choice of building material. To boost the U-value further, 100mm of Kingspan Thermawall urethane insulation was installed outside the ▸

panels too.

The old steel beams run right from the concrete base up to the roof, so wrapping the perimeter in EPS below ground cut thermal bridging here. Meanwhile Kingspan Unidek Aero SIPs — which contain graphite EPS insulation sandwiched between two layers of particle-board — form the insulating layer for the roof.

The airtight wrap of the building is formed by the damp proof membrane (DPM) under the floor insulation, the internal OSB for the walls, and a Siga Majpell membrane under the roof panels. Siga tapes were used on all the critical junctions, and lots of taping was required around the tricky junctions between the DPM and the steel columns.

An early airtightness test showed some air leaking through the OSB, so wet plastering the walls inside provided an extra seal. The final blower door test result was 0.4 air changes per hour.

"Everybody was chuffed to bits, really chuffed," Rob Harwood, construction manager at Arden Construction, says of the result. "It was their first [passive house], it was our first one, it was quite a steep learning curve for both. But it all worked."

Harwood says the support available from Nick Grant and Siga was vital to the success of the build. "I think it went relatively smoothly. There were more issues with drainage than there were with anything else," he says, adding that everyone on the team was eager to embrace passive house.

"It was something new, it was something ▶

different, it's a fantastic setting." He says he would happily take on another passive house project.

The studio is heated with a gas combi boiler that supplies underfloor heating. Meanwhile a Paul Novus system provides mechanical heat recovery ventilation (MVHR), and was installed on one of the mezzanines.

"What we've decided is expose it so you can see the machinery," Shely says of the MVHR unit. "We think it looks quite cool, we've got all the ductwork exposed so that you can see how this building works."

Extensive glazing on the south and north facades provide natural cross ventilation too. As well as bringing in daylight and fresh air, these windows frame the surrounding countryside, and a wildflower meadow on the site.

Having lots of glass could risk leading to overheating and glare, but the external insulation creates deep reveals to mitigate this, and there are brise soleils externally on the south and west facades. Pushing the U-values of the other building elements even further compensated for any excess heat loss through the north-facing glass.

Shely says: "We paid a huge amount of attention to the detailing of the building. What we wanted to do was create a balance between the physics and the architecture. You can see that we've got huge amount of glazing. We wanted to bring as much daylight into the building as possible because it's a workspace. We wanted it to feel quite light and airy."

Along with the ventilation ducting and electrical wiring, the old rusted steel frame is exposed inside. This creates a striking contrast between the white walls and wood finishes. Externally the building is clad with western red cedar, accentuating its warm, natural feel.

Sjölander da Cruz moved into the building in January, and named it River Studio, for a tributary of the Avon that runs along the edge of the site. In September the firm began a year long programme of post-occupancy monitoring.

"In the summer we've noticed that even when it's quite warm outside, it still feels comfortable," Shely says. In winter, she adds, the expanses ▶

(clockwise from top) the old asbestos-clad shed which was retrofitted to the Enerphit standard; erection of the Kingspan Tek structural insulated panels (SIPs); a close-up of one of the panels, which consist of urethane insulation sandwiched between two layers of OSB, outside the steel frame; 100mm of additional Kingspan Thermawall insulation was installed outside the SIPs; a blower door test being carried out to measure air leakages in the building; a thermal imaging survey carried out by Nick Grant to detect any areas of heat loss; the building is now clad externally with western red cedar; (p53, main picture) the heat recovery unit is installed on one of the mezzanines, with all ductwork and machinery exposed; (p51) all cladding was removed from the old shed, leaving only the original steel frame, which was left exposed inside the finished studio

of south-facing glass bring both heat and light into River Studio.

"The air quality is one of the things that everybody has noticed," she says. "There's a great quality of light within the space, and the views towards the surrounding landscape just make it a great place to work."

**SELECTED PROJECT DETAILS**
**Client & architects:** Sjölander da Cruz Architects
**Contractor:** Arden Construction
**Energy consultant:** Elemental Solutions
**M&E Engineer:** Alan Clarke
**Civil & structural engineer:** Bob Johnson Consulting Structural Engineers
**Airtightness membranes & tapes:** Siga
**SIPs supplier & installer:** Lowfield Timber Frames
**SIPs manufacturer:** Kingspan
**Mechanical contractor:** Blue Diamond
**Electrical contractor:** C&L Electrical
**Airtightness tester:** Coventry University
**Passive house certification:** Warm
**Additional wall insulation & floor insulation:** Kingspan
**Slab perimeter insulation:** Sto
**Window supplier:** Spectrum Installations
**Roof windows:** Velux
**Brise soleil:** Dales Fabrications
**Timber cladding:** Vincent Timber
**MVHR:** Blue Diamond
**Screed:** Flowcrete UK
**Ventilation supplier:** Lindab
**Lighting:** Artimede
**Steel roofing:** Tata Steel

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## PROJECT OVERVIEW:

**Building type:** retrofit of mid 20th century asbestos-clad shed into modern architectural studio.

**Location:** Leamington Spa, Warwickshire

**Completion date:** December 2013

**Budget:** £267,765.80

**Space heating demand (PHPP):** 18 kWh/m²/yr

**Heat load (PHPP):** 14 W/m²

**Primary energy demand (PHPP):** 95 kWh/m²/yr

**Passive house certification:** Enerphit certified

**Measured energy consumption:** Post occupancy monitoring began in September 2014 and will take one year to complete

**Airtightness (at 50 Pascals):** 0.4 air changes per hour

**Walls:** 22mm Western Red Cedar cladding externally, followed inside by continuous layer of black insect mesh, 38x50mm vertical timber battens at 500mm centres, Siga Majvest wind-tight membrane (joints taped with Siga Wigluv 60), 100mm Kingspan Thermawall TW55 urethane insulation, 142mm Kingspan TEK SIPs with internal OSB serving as airtight layer (Siga Sicrall used to seal OSB joints), 15mm British Gypsum Fireline plasterboard with skim coat finish. Below DPC: Sto EPS insulation around perimeter of concrete slab. Wall U-value: 0.106

**Roof:** Standing seam steel roof externally, followed underneath by Tyvkek metal open drainage membrane, Kingspan Nilvent breathable membrane, 18mm WBP deck, Kingspan Unidek Aerodek SIP comprising 234mm EPS insulation core between two layers of particleboard, Siga Majpell vapour control layer to underside of Unideck system to provide airtightness (lapped over OSB in walls by 150mm), 15mm British Gypsum Fireline plasterboard and skim finish internally. U-value: 0.127

**Ground floor:** Continuous DPM (also the airtight layer) on existing concrete slab and brought up to connect with airtight OSB layer of walls (Siga Rissan 60 used to seal DPM joints), 120mm Kingspan K3 Floorboard insulation over the DPM, followed above by 20mm underfloor heating pipes embedded in 65mm Flowcrete K screed with polyurethane resin floor finish & polyurethane matt seal. U-value: 0.13

**Windows & door:** Internorm HF200 aluminium-clad timber units. Overall U-value: 0.8 (for standard sized window).

**Roof windows:** Velux GGL 3065 triple-glazed pine-finished roof windows. Overall U-value: 1.0

**Heating system:** Worcester Bosch Greenstar 28CDi compact condensing gas boiler (space heating and hot water).

**Ventilation:** Paul Novus 450 mechanical heat recovery ventilation system. Passive House Institute certified heat recovery efficiency: 89%

**Green materials:** Western red cedar cladding.

A passive retrofit in Co Meath offers a template that could be applied across much of the Irish housing stock: a long, dark, 1970s bungalow was transformed into a bright modern home that's now warm and comfortable.

**Words: John Hearne**

Homeowner Paul Tully says that he and his wife Deirdre spent ten years trying to figure out what to do with their old house.

"It was cold and draughty and very expensive to heat. And we didn't have enough space; we needed more bathrooms. So we watched Grand Designs and all of the building shows on TV, we went to all of these building and energy exhibitions, and we also went to see a couple of passive houses being built. We realised then that that was what we wanted. Something cheap to run and warm."

The planning process did not go smoothly, however. The Tullys started out looking for a

# How to rescue a 1970s bungalow

Photos: Energy Quarter / Gitta Hammond

modern extension on the site of the bungalow, but the planners rejected the idea, saying that it would look out of kilter with the surrounding houses. Though it would have presented the builders with a more straightforward proposition, demolishing and rebuilding was also out of the question.

The Tullys then suggested to the planners that they convert their elongated bungalow into a modern dormer house by extending the house upwards by half a storey. This plan was accepted.

Stephen Young of Young Design Build was contracted to design the house. While Young is a veteran of passive building, this was his first project to aim for Enerphit, the Passive House Institute's retrofit standard. It's not quite as exacting as the new build standard – the airtightness threshold is a little lower, as is the space heat demand – but refurbishing an old house to achieve these targets can be considerably more challenging than starting on a greenfield site.

Moreover, the design brief extended well beyond achieving passive thresholds. Stephen Young explains: "The client wanted to increase the area in the house, he wanted to make it more open, he wanted the bedrooms to be enlarged, and ensuites added to all of them. Because we were going to undertake a huge amount of work, it made sense to remove the roof and go for a storey and a half."

The house was stripped back to its bare bones. The roof was demolished along with all of the internal walls, to leave just the foundation and the external walls. While retaining these features did help limit the cost of the job, working around them created other headaches.

"The demolition and removal process was very time consuming," says Young. "Also, you have to be very careful on a building site where there's tarmac in place, and existing landscaping." Taking the care required to preserve all of these features, he says, tended to slow everything down.

As is frequently the case in refurbs like this, unforeseen issues arose. After the roof was removed, the team discovered a concrete ring beam that extended right around the house. It had been poorly installed and sections of it had to be removed, which further slowed the work. The house also featured a combination of floor slab and suspended floors, all of which had to be taken out.

Once the house was reduced to a shell, there was sufficient space to begin installing the insulation required to bring it up to spec. The existing cavity walls had been pumped with a fibre insulation in earlier years, so it was decided to leave the cavity untouched and to externally insulate the walls with EPS. The windows were moved to the outer leaf to help accommodate the insulation, which created a continuous envelope all the way round the house and helped to limit thermal bridging.

Removing the bungalow feel from the house was central to the whole design process. With the internal walls gone, the team could completely revamp the internal layout, creating the open-plan arrangement that the client sought.

Externally, the facades were realigned to render them unrecognisable compared to the original design. "We changed the orientation of the windows," Young explains. "Instead of the long, horizontal windows, we broke out openings and used vertical windows in the west elevation. In the south, we went with floor to ceiling window heads. That changed the dynamic of that whole facade."

The original bungalow featured an extension from the eighties, which simply added to the length of the building, making it even longer and even narrower. This made all attempts to modernise the look and feel of the house that much more challenging. "We brought in Parklex cladding to the main entrance in order to break up that elevation," says Young. "Instead of screwing the Parklex boards back to the substrate, we went with an adhesive system, so there are no visible fixings."

Heating is delivered via an external Dimplex air to water heat pump and underfloor heating. There is also a 4kW solar photovoltaic array split between the east and west roof elevations. The combination of upgraded building fabric and renewable technology has propelled the house from a E2 building energy rating to a conservative A3. The BER assessment was done prior to the airtightness test, and without using the Irish methodology for calculating thermal bridges, meaning punitively bad air leakage and thermal bridging defaults were used.

To prevent summer overheating, the design ▸

(top left) the existing bungalow's roof was demolished along with all of the internal walls; (top right) the ground floor was insulated with Xtratherm Thin-R PIR insulation; (bottom left) the dwelling was extended upwards by half a storey as part of the refurbishment; (bottom right) the walls were externally insulated with platinum EPS

team installed external fabric blinds, which were incorporated into the external insulation. Made of a semi-transparent material, the visual connection with the outside is retained even when the blinds are lowered. They filter out the sun's UV rays and limit the solar gain that might otherwise overheat the house during the summer months.

"The client felt that because we were doing that to the outside," says Young, "they didn't need to install blinds or curtains to those windows, so it left the internal spaces looking a lot more pure. The client found it aesthetically very pleasing."

While 0.6 air changes per hour is the required airtightness standard for new passive buildings, 1.0 is deemed sufficient for Enerphit projects. The team nevertheless managed to achieve a very impressive result of 0.448 air changes per hour on the first attempt.

This was largely achieved through a wet plaster finish internally. "No top of the range additives or systems," says Young, "we didn't use any of the airtight plasters or anything like that."

That said, the process of achieving such a high standard of airtightness did require careful detailing and scheduling, with everything worked out ahead of time on paper. Once external walls were chased, the cavities had to be sealed ahead of the first electrical fix. Similarly, all airtightness details had to be completed before moving on to creating the first floor. Galway-based company Partel supplied Ampack airtightness tapes and membranes for the roof construction and windows.

"It's been brilliant — warm, spacious, comfortable. We don't know about the economics yet. Once we get into the winter we'll find out, but we haven't put on the heating yet."

The ventilation strategy required to complement this airtightness is largely delivered by a Paul Novus mechanical heat recovery ventilation system, installed in a soundproof closet adjacent to the master bedroom. Homeowner Paul Tully says there are no noise issues with the technology. In fact, one of the big advantages of the passive standard building envelope is noise reduction.

"We live on the N2," he says, "which is a very, very busy road. You get lorries going up and down the road from five in the morning. Now, with the triple-glazed windows, you can't hear them. It's only a gentle sound in the background."

He goes on to say that in delivering the project, there were two major difficulties. "Planning and money. They were the hardest. The actual

construction of the building went very, very smoothly."

The family moved in at the beginning of the year, and so far, so great. "It's been brilliant," says Tully, "warm, spacious, comfortable...We don't know about the economics yet. Once we get into the winter we'll find out, but we haven't put on the heating yet."

**SELECTED PROJECT DETAILS**
**Clients:** Paul & Deirdre Tully
**Architectural design, M&E, contractor & passive house consultancy:** Young Design Build
**Electrical contractor:** Kierans Electrical & Security Systems
**Airtightness testing:** Greenbuild
**External wall insulation:** Kilsaran
**Roof insulation (Metac mineral wool):** Isover
**PIR insulation (roof, floors):** Xtratherm
**Airtightness products:** Partel
**Windows & doors:** Young Design Build
**Roof windows:** Velux
**Solar photovoltaics:** PV Tech
**Parklex cladding:** Elemental
**Heat pump:** Glen Dimplex
**Heating contractor:** Penarch
**Underfloor heating:** Unipipe
**Roof slates:** Tegral

## Want to know more?

**Click here to view additional information on these projects, including an online gallery featuring illustrations, photographs, and project overview panels.**

***This content is exclusively available to our digital subscribers.***

(below) there is a 4kW solar photovoltaic array split between the east and west roof elevations; (above) Parklex rainscreen cladding helps to break up the main elevation; (above right) external blinds help to prevent overheating

## PROJECT OVERVIEW:

**Building type:** Single-storey 157.6 square metre bungalow from 1970. Enerphit refurbishment and extension to a storey and a half. Total floor area now 286.4 square metres.

**Location:** Beaupark, Navan, Co Meath

**Completion date:** Jan 2014

**Budget:** Not available

**Passive house or Enerphit certification:** Pre-submission

**Building Energy Rating**
**Before:** E2 (343.16 kWh/m²/yr)
**After:** A3 (70.84 kWh/m²/yr. The BER was processed before the airtightness result was input. If updated, it would improve to 55.21 kWh/m²/yr, on the cusp of an A2).

**Space heating demand (PHPP):** 15 kWh/m²/yr (provisional)

**Heat load (PHPP):** 8 W/m² (provisional)

**Primary energy (PHPP):** 69 kWh/m²/yr (provisional)

**Airtightness after retrofit (at 50 Pascals):** 0.448 air changes per hour

**Thermal bridging factor:** A punitive default Y-factor of 0.15 W/m²K was used in Deap.

**Floors**
**Before:** A mixture of suspended and solid floors. U-value circa 0.65 W/m²K.
**After:** 200mm Xtratherm Thin-R above new radon barrier with a 100mm concrete floor screed. U-value: 0.107

**Walls**
**Before:** Original concrete cavity walls with 60mm cavity pumped with fibre insulation, U-value: 0.55. 1980s extension cavity walls pumped with white EPS insulation. U-value: 0.51

**After:** 200mm & 250mm Platinum EPS insulation and Ceresit acrylic render finish externally to original walls & 1980s extension. U-value: 0.095 & 0.082 to original walls, and 0.10 & 0.083 to walls of 1980s extension. Parklex-clad walls sections over 180mm Platinum EPS insulation to existing walls (south & west facades). U-value: 0.109 & U-value: 0.102

**Extension walls (1st floor):** 200mm Platinum EPS insulation and Ceresit acrylic render finish externally to concrete block walls with internal sand/cement render and skim coat finish. U-value: 0.128

Parklex rainscreen cladding externally followed inside by/ 220mm Metac insulation to timber frame walls filled with 140mm Metac insulation; Durelis air tightness racking board, 25mm Xtratherm Thin-R; 40mm service void and plasterboard. U-value: 0.099

**Roof**
**Before (demolished):** Insulated at ceiling level with 50mm mineral wool insulation on flat. Roof tiles externally, plasterboard ceiling internally. U-value: 0.68
**After:** New slate roof with sloped insulation and insulation on the flat. 220mm Metac Insulation with 25mm Xtratherm Thin-R to sloped roof areas. Ampatop Protecta Plus breathable roof felt with integrated windtight tapes externally and Ampatex DB 90 vapour check and airtight membrane internally (plus Ampacoll tapes for airtightness). Also 200mm Metac Insulation with 25mm Xtratherm Thin-R at ceiling level with a 40mm service void and plasterboard ceiling internally. U-value: 0.14

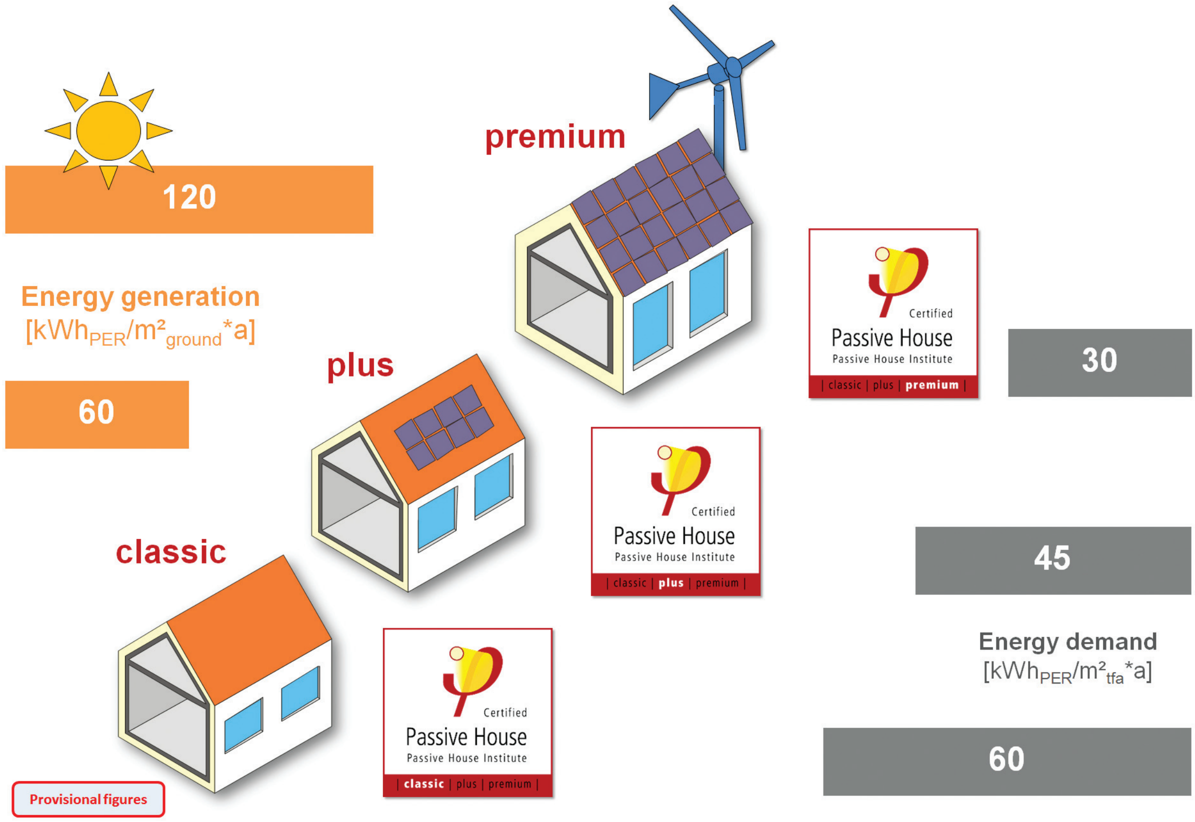
**Windows & doors**
**Before:** Double-glazed, timber windows and doors. Overall approximate U-value: 2.5
New triple-glazed windows: Energate EN1202 triple-glazed timber aluclad windows and doors. Passive House Institute certified. Overall U-value of 0.83, or 0.85 installed (PHI cert).

**Roof windows:** Velux GPU Class 5 airtightness thermally broken triple glazed roof windows with white polyurethane frames and installed with BDX insulation collar. Overall U-value: 0.85

**Heating system**
**Before:** 20 year old oil boiler & radiators throughout entire building
**After:** Dimplex LA9MI air source heat pump with Harp database registered SPF of 355% fitted with a Unipipe underfloor heating system.

**Ventilation**
**Before:** No ventilation system. Reliant on infiltration, chimney and opening of windows for air changes.
**After:** Paul Novus 300 heat recovery ventilation system. Passive House Institute certified to have heat recovery rate of 93%

**Electricity:** 26.72m² solar photovoltaic array with average annual output of 4kW split east/west.




Images: Passive House Institute

# THE NEW PROPOSED PASSIVE HOUSE CLASSES EXPLAINED

The Passive House Institute's announcement of new classes of passive house certification – including renewable energy generation – at this year's International Passive House Conference caused something of a stir. **Dr Benjamin Krick**, the institute's head of component certification sheds some light on the new classes and explains the rationale behind proposals which may set up passive house for a fabric first approach to near – and sub – zero energy building.

The evaluation of a building's energy demand typically takes into account its consumption of non-renewable primary energy, such as electricity generated by coal, gas or oil-fired power plants. This primary energy (PE) principle includes the evaluation of the generation and supply chain that energy must go through to arrive at our buildings. Energy losses occur on the way from the oil spring in the Saudi Arabian desert to the oil storage tank at home, due to transport and refinement of crude oil to heating oil. These sorts of losses are evaluated via the primary energy factor.

According to EnEV, the German regulation for energy saving in buildings and building systems, heating oil has a PE factor of 1.1 – a loss along the generation chain of 10%. However, PE factors are generally not determined by exact science but by politics, even though they are used to evaluate the energy demand of buildings according to regulations such as EnEV. This works in a reliable way as long as the energy supply system is mainly based on non-renewable sources. But the situation changes with higher shares of renewable energy.

Right now, only non-renewable primary energy is taken into account in most European countries. Take the example of wood in the form of split logs, which consists principally of renewable primary energy – namely the solar energy that the tree stored in the form of carbon during its growth. Only a small fraction of the energy used to produce this wood comes from non-renewable sources, such as for cutting, chopping and transportation. We know that if we disregard the stored solar energy in the logs, the primary energy factor of the split logs is approximately 0.05 (though according to EnEV a factor of 0.2 has to be used). On EnEV's terms it follows that if wood is used instead of oil to heat a building, more energy may be consumed. However wood, too, is a resource that is limited in its availability.

Electricity is a mix of renewable and non-renewable sources. Old coal power plants produce electricity with a non-renewable primary energy factor of about three. To produce one part electricity, three parts of primary energy in the form of coal are burnt. No fossil energy is required for electricity generation in wind or solar plants. For this type of electricity, the non-renewable primary energy factor is treated as zero by EnEV. If the mix of renewable and non renewable sources used to generate electricity changes, the resulting non-renewable primary energy factor for electricity changes too. According to EnEV, the factor has been reduced from 3.0 via 2.7, 2.6 and 2.4 in the past to 2.0 now. In the year 2016 it's expected to further decrease to 1.8 – in large part because of the growing contribution from renewable energy systems into grid electricity supply, which is regarded as having zero primary energy. If we follow this line of thinking, the non-renewable primary energy factor will tend towards zero and will be zero, if transition to 100% renewable energy is accomplished – assuming we accept the notion that we can disregard primary energy from renewable energy sources. Should that happen every building, independent of its actual end energy demand, will have a primary energy demand for electricity of zero. Already this approach shows that using the non-renewable primary energy demand as the sole scaling system has become inappropriate for the sustainable evaluation of energy efficiency in buildings.

**Future evaluation of the energy supply: PER system**

In principle, one possible solution could be to add the renewable primary energy demand to the non-renewable primary energy demand. In this case, wind energy has a total primary energy factor of one, and for wood it would be 1.2, based on EnEV data. At first sight, this solu-

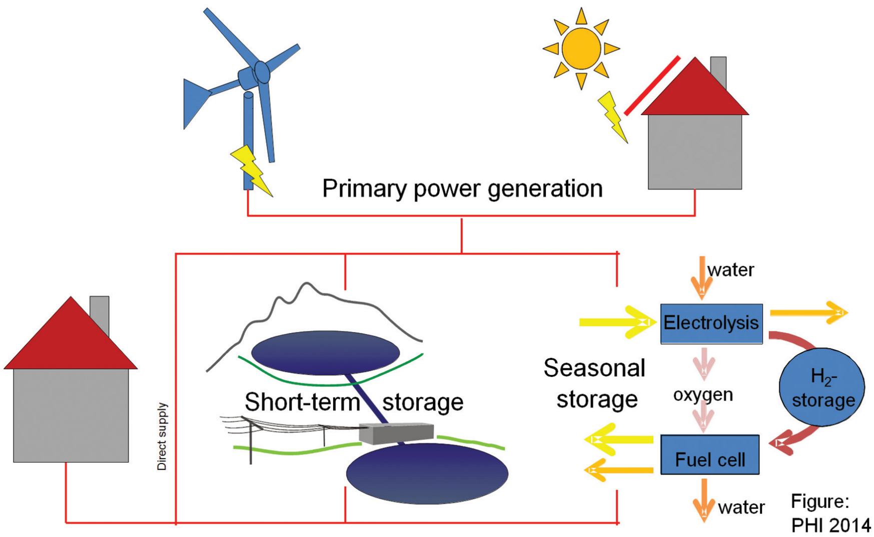


Figure: PHI 2014

tion seems viable. However, renewable and non-renewable energies cannot be compared with each other: while the use of non-renewable energy leads to dramatic and permanent or difficult-to-reverse damage (climate change, air pollution, nuclear risks), problems resulting from the use of renewable energies are often more aesthetic (visual destruction of landscapes, reflective effect of solar systems on roofs) and feasible to resolve in principle (e.g. the debate about the use of biofuels for food vs fuel). Considering this, it is evident that a simple addition of renewable and non-renewable primary energy is not appropriate for evaluating their combined impact on the environment.

The solution proposed by the Passive House Institute is simple. This scenario assumes a successful energy transition where only renewable energies are used. These are mainly wind and sun, from which primary electricity is produced, along with some hydropower and biomass plants. This system too has losses along the generation and supply chain, which are evaluated via PER factors (Primary Energy Renewable). The completely renewable primary electricity produced in this way is assigned a primary energy factor of one.

Apart from the energy sources, this model includes two types of storage systems: short-term storage via pump storage power plants, and long-term storage, which is based, for example, on hydrogen-methane. As wind and sun are not constantly available, the short-term storage is filled up first in times of over-generation. The efficiency factors of pump storage power plants currently lie between 75-80%. Once the storage is full, the surplus energy is converted via electrolysis into hydrogen (H2) and/or further into methane (CH4) and fed into the natural gas network (power-to-gas, PtG). We already have sufficiently large methane storage capacities to ensure a secure energy supply.

If insufficient renewable electricity is available, first the short-term storage and then the long-term storage is emptied. Although the 40% efficiency of the long-term storage is significantly lower than the efficiency of the short-term storage, it is still in the region of current electricity generation.

**First results for the new approach**

It is now necessary to determine primary energy factors for individual applications. For example, hot water demand is relatively constant over the course of a year. It is possible to determine an optimal combination of wind and solar for this constant demand to minimise the burden on stored electricity as much as possible. The wind blows more in winter, and in summer solar offers more. These two primary electricity carriers complement each other quite well. In addition, hot water can be stored locally in stores which are typically used today. Thus, the possibility exists to bridge hours with a low renewable supply and load the hot water storage in times of a surplus of renewable supply. The first calculations by the Passive House Institute result in a PER factor for stored hot water from electrical sources of approximately 1.3.

Similarly constant over the course of a year is the household electricity demand. However, buildings do not offer storage possibilities for this and therefore grid-connected stores must be used. This results in a PER factor of approximately 1.4, which is also applicable for hot water from electric instantaneous water heaters. because there are no storage capacities in the building available if this system is used.

Space heating demand occurs mainly during the winter. In a completely renewable scenario, gas heating may cover the space heating demand (through renewable electricity converted to methane) with a PER factor of 1.8. Electricity-based heating systems put a lot of pressure on the methane-based long-term storage with its low efficiency. Here, the primary electricity mix is wind-dominated as this energy source performs better in winter. Therefore, a PER factor of 1.7 can be calculated for the electricity-based heating of buildings. If a heat pump with a seasonal performance factor of, for example, 2.5 is used for heating, then 1/(1.7/2.5)=1.47 parts "heat" can be produced from one part primary electricity. Thus the heat pump has a better result than a gas boiler which produces 1/1.8=0.56 from one part primary electricity. As a result, the heat pump will be the preferred heating system in the future. This should influence decisions made today, because buildings built or retrofitted today will still be here when the energy transition has been accomplished.

The Passive House Institute is currently working on the completion and detailed description of the PER concept, such as the inclusion of biomass and water power as well as the adaptation to different climate zones and the definition of boundary conditions. This work is due to be completed in the next few months and will then be incorporated in the new version of PHPP (the Passive House Planning Package).

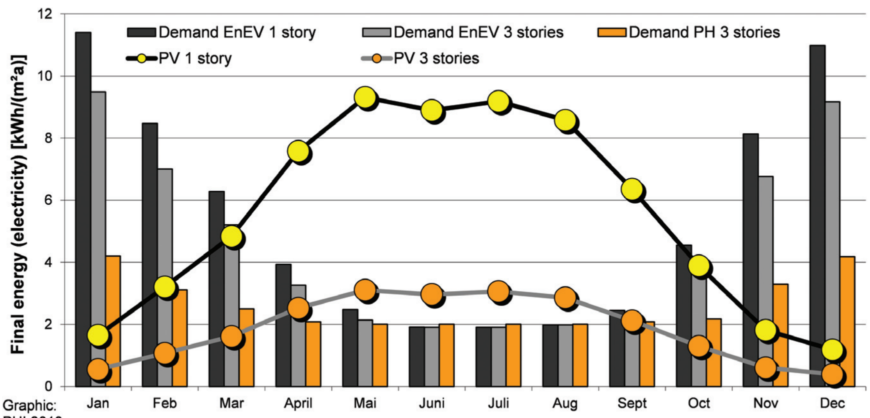
**Classification of buildings according to PER demand**

Independent from the development of the energy supply structure, the efficient use of energy in the building remains crucial. From the beginning, this efficiency-first-approach has been at the heart of the work carried out by the Passive House Institute as well as of the passive house standard itself, along with comfort and hygiene requirements.

As an example, a maximum annual space heating demand of 15 kWh/m²yr is required, which is typically the economic optimum in central Europe. This is such a small amount of energy that it can easily be supplied in a sustainable manner.

In southern Europe, the economic optimum leads to even lower space heating demands, but it has to be taken into account that this optimum is very flat here. Furthermore, there are regions in Europe where the classic passive house is not yet the economic optimum. This may be due to factors specific to those regions, such as the lack of, or excessive cost of, components, lack of knowhow and subsidized energy prices.

Space heating is not the dominant heat demand in highly efficient buildings. In passive houses, it is domestic hot water. But demand for household electricity is generally much higher. Here, when combined with the chosen heating and DHW system, the highest efficiency potentials can be found. To work out the total energy demand of a building, an additional evaluation ▶



Graphic: PHI 2013

is required. As described, the PER system can be applied to carry out this evaluation.

The generation and use of renewable energy sources for buildings makes sense and is required by the EU Energy Performance of Buildings Directive. However, buildings must not be reduced to a function as carriers of energy generation plants. Approaches which directly offset generation and demand in the annual balance will inevitably lead to misguided optimizations, because generation of solar electricity in summer cannot directly offset a demand in winter. Between generation and demand there is a chain of transition, storage and, again, transition.

It is relatively easy to transform a bungalow into a plus energy house in the annual energy balance. In comparison to the useful area, a large roof area is available which, when covered with photovoltaics, allows for lots of solar generation during the summer. The building does not need to be very efficient to obtain an equilibrium in the energy balance based on space heating demand. But storage losses are typically not included in this equation. And if a multi-storey building is needed, which has a smaller footprint and is more ecological, it will be much harder to accomplish an equilibrium in the energy balance due to the worse roof-to-useful-area ratio.

Here, the PER system offers a solution of a correct offset of generation and demand: onsite generated electricity is primary electricity and will be evaluated with a PER factor of one. Unlike the current situation where methodologies such as EnEV, Deap and Sap give a primary energy reward to onsite renewables by displacing grid electricity – which has current primary energy factors of more than two – this energy isn't seen to be displacing more than a kilowatt of grid electricity, because this proposal assumes completely renewable primary electricity with a primary energy factor of one. Meanwhile, application-dependent PER factors (such as generating hot water) are assigned to the demand.

Taking the above into account, the issue of multi-storey buildings still needs to be resolved. A building uses a certain area – the building's footprint – with the result that this area is no longer available to the public. Through the generation of energy it is, however, possible to make positive use of this area for the public. The Passive House Institute therefore proposes to relate the energy generation not to the useful area (or living area or treated floor area) but to the building's footprint.

Based on these thoughts, the Passive House Institute has proposed the introduction of new certification classes. These classes are orientated to the PER system in order to evaluate buildings according to demand and generation. The values for PER demand and primary electricity generation still require a detailed determination and are preliminary. To achieve certification in a particular class, it will be possible to compensate lower energy generation with higher efficiency.

**Energy Saving Building:** Space heating demand max. 30 kWh/$m^2$yr; PER demand max. approx. 75 kWh/$m^2$tfa*yr.

**Passive house Classic:** Space heating demand max. 15 kWh/$m^2$yr; PER demand max. 60 kWh/$m^2$tfa*yr.

**Passive House Plus:** Space heating demand max. 15 kWh/$m^2$yr; PER demand max. 45 kWh/$m^2$tfa*yr; Primary electricity generation min. 60 kWh/$m^2$ground*yr based on the building's footprint.

**Passive House Premium:** Space heating demand max. 15 kWh/$m^2$yr; PER demand max. 30 kWh/$m^2$tfa*yr; Primary electricity generation min. approx. 120 kWh/$m^2$ground*yr based on the buildings' footprint.

The premium-class is very hard to achieve and thus is dedicated to ambitious individuals who want to go beyond what might be considered economically and ecologically optimal, based on current technology.

**What the new passive house classes actually mean**

A passive house in Gerstetten, Germany shows how the new passive house classes can be achieved. The author thanks the passive house architect Prof. Dr. Werner Friedel for the opportunity to carry out a study on the basis of this house. At present the building is heated by a wood pellet boiler. On the roof a 74 $m^2$ photovoltaic (PV) system is installed (version 1). The building is highly energy efficient, with an annual heating demand of 11 kWh/$m^2$tfa*yr, which is reflected in an airtightness value of 0.14 ACH. With a PER-demand of 60 kWh/$m^2$tfa*yr it just reaches the criteria of Passive House Classic, and the PER-generation is 53 kWh/($m^2$Ground*yr) – falling short of the threshold for Passive House Plus.

If a small 6$m^2$ solar thermal collector is added for hot water, the PER requirement reduces to 54 kWh/$m^2$tfa*yr, and the generation increases to 65 kWh/$m^2$ground*yr (1a). On the generation side, the Passive House Plus target is thus achieved, but the building fails the demand of maximum 45 kWh/$m^2$tfa*yr. Already in this variant the building delivers a slight energy surplus with regard to final energy. Tripling the collector to 18 $m^2$ would change little, since the energy produced especially in the summer cannot be fully utilized because the (now 2000 l) hot water tank is already fully charged (1b).

Version 1c, again with a 6 $m^2$ solar thermal array but also additional heat recovery from shower water, sees an improvement of the hot water distribution system. This variant, with a PER-demand of 45 kWh/$m^2$tfa*yr and a production of 60 kWh/($m^2$ground*yr), reaches the Passive House Plus standard. Compared with variant 1a, it's noticeable that the energy generation is less, despite using the same collector. This can be easily explained by the significantly lower domestic hot water demand. Less energy is needed, so the solar system is replacing less energy. In this variant, demand and generation is balanced with regard to renewable primary energy.

Since the passive house in Gerstetten needed only a bit more energy than provided by the biomass boiler, due to its high efficiency, the effect on the renewable primary energy demand by changing the boiler's fuel from pellets to gas can be nearly neglected (2).

However, if a heat pump is used, the rating changes significantly: In variant 3 with an air-to-air heat pump, the PER-demand decreases already to 40 kWh/$m^2$tfa*yr. On the demand side, the Passive House Plus class is reached, and the PER demand and generation is already balanced. The switch to a brine-towater heat pump (3a) reduces the demand further to 34 kWh/$m^2$tfa*yr, and with 85 $m^2$ of PV the Passive House Plus class and a significant PER-surplus are achieved.

For Passive House Premium some things are missing: optimization of the mechanical and electrical technology alone is not enough. Changes to the building envelope are required. If installed Passive House phB- class windows are replaced with class phA the annual heating demand reduces to only 8 kWh/$m^2$tfa*yr. Together with the shower hot water heat recovery and the optimization of the hot water distribution as in variant 1c, and with full-scale occupation of the roof with a 123 $m^2$ photovoltaic array, version 3b achieves a PER demand of 30 kWh/$m^2$tfa*yr, meeting the target required by Passive House Premium. But the generation figure of 88 kWh/$m^2$ground*yr is still too low, although now about twice the amount of energy required in the building is generated. Other actions would be the availability of the garage roof or south facade with PV, or, for example, investing in a community wind turbine. A proportion of 3 kW of installed capacity, which is about five-hundredths of a modern, installed inland wind plant would be sufficient to achieve Passive House Premium – and almost to produce three times the amount of energy required.

**Impact of PER-classification function of the component parts used**

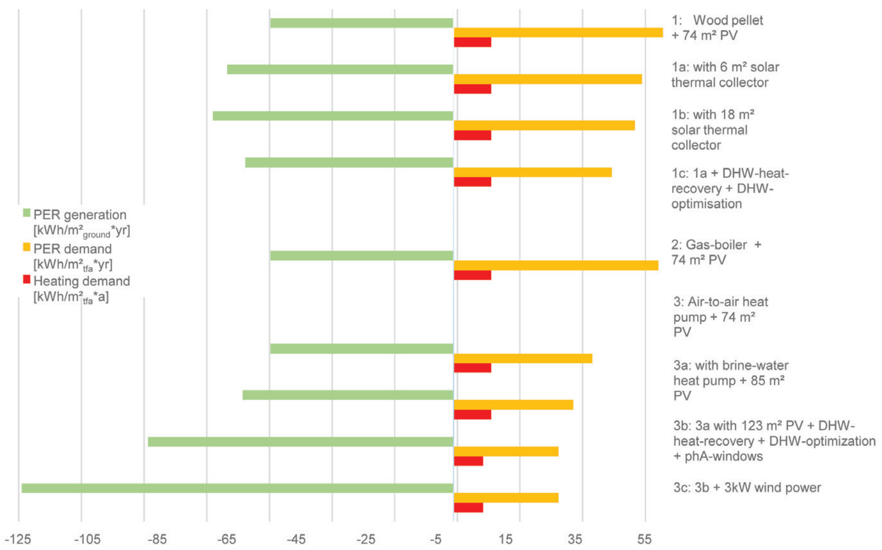


Photo: Gavin Ó Sé

# WILL BUILDING BOOM SEE LOW ENERGY FAILURES?

Low energy building isn't complicated, but it's easy to get wrong. Since Irish house builders downed tools en masse when the last boom ended, energy efficiency standards for new homes have seen unprecedented rises of 40% in 2008 and 60% in 2011, shooting far ahead of the UK. But with signs of a new boom emerging, can the industry get to grips with this brave new world of insulation, airtightness and thermal bridging and deliver healthy low-energy homes — or are damp and mould set to become the norm in new build?

**Words: John Hearne**

Simon Jones of ventilation technology company Aereco took a call recently from an architect looking for advice. The architect was working on a residential development that had just been completed, but there was a problem.

Jones drove out and met the architect, the engineer and developer at the site. "We took a walk around the houses and in dead space areas on the development, areas where you wouldn't get free flowing air, we found mould and condensation. And this is before anyone had even moved in. Behind wardrobes and in corners near skirting boards; mould and condensation."

Jones isn't the only building professional to have run into mould in new houses in the last few months. Gavin Ó Sé of Greenbuild in Co Wexford was also called in to advise on an almost identical issue. "The contractor had installed good insulation and achieved good airtightness results, but in one or two of them, he had been called back for condensation build up," Ó Sé says.

And Archie O'Donnell of Integrated Energy and Coda Architects has also had recent experience of condensation and mould in new builds. In fact, all of the professionals interviewed for this piece had a ready stock of stories of how poor ventilation strategies in particular, and questionable building practice in general, continue to dog Irish construction.

These issues, Simon Jones points out, are not new. He's been discovering condensation and mould in new buildings for at least the last five years. His concerns – and those of many others in the industry – centre on the tentative resurgence in building activity and what it implies for the quality of construction.

Jones points out that during the recession, most house building in Ireland fell into one of two categories. "One is council driven," he says. "New builds for the likes of Ballymun regeneration or Limerick regeneration, where specs are being led by councils who have demanded certain performance levels. Or else you have the passive house, one-off builder who has been building ever better homes over the last half decade." Both categories of builder have

an obvious vested interest not alone in delivering a cost-effective project, but also in ensuring that the structures they build provide a safe, low cost, high comfort living space for decades to come.

But now things are changing. The Ulster Bank Construction Purchasing Managers Index, a measure of activity and sentiment in the sector, recorded an increase in construction activity for each of the last 13 months. Meanwhile, September's housing market report from the Society of Chartered Surveyors said that 35,000 new houses will be needed to meet rising demand in Dublin over the next four years.

The risk that Jones and others have identified is that developer-led construction brings a whole new set of priorities to the equation. "Quantity surveyors get involved and begin looking for ever cheaper products. They start looking to cut corners, they start asking questions: What can we get away with? Do we really need that? The danger is that there will be a race to the bottom with specification, a race to the bottom with skills, with labour...This is a high risk time," he says.

None of this is to imply that a return to growth isn't welcome, and Jones, while pointing to the risks, is also quick to point out that the industry stands to benefit from the commercial rigour that professional developers will bring. One of the central challenges facing the industry as it begins to pick itself up again centres on skills. The 93,000 houses that went up at the peak of the cycle in 2006 were subject either to the 1997, 2002 or 2005 versions of Part L. Many of the builders responsible for those houses were abruptly sidelined by the property collapse. Now, as they return to building sites, they're being asked to build to a much more demanding standard.

"A lot of builders struggled through the last five or six years," says energy consultant Mark Shirley of 2eva in Carlow. "They got by doing extensions or small refurbishments. Now they're looking at coming back, and the landscape has changed completely in all sorts of ways."

The revised building regulations 2011 have effectively upgraded the minimum standard from a B3 rated property in 2005 to an A3 today. Backstop U-values have been radically overhauled, thermal bridging has been addressed. While the airtightness requirements remain weak, they are still far more strenuous than ten years ago. Builders must now deliver a 60% overall improvement in the energy performance of new dwellings compared with 2005. The question is, can they do it?

Martin Flattery runs Mulberry Properties, a development company which just finished an estate of A2-rated houses in Straffan, Co Kildare. He says his decision to aim higher than the building regs was predicated on commercial reality: build better and your investment will pay off. "Customers are a lot more educated than they used to be. There are a lot of A-rated houses out there, A3 is becoming the norm, so we decided to push beyond that," he says.

It's a view that most of the builders interviewed for this piece share. Developer Joe McGowan, who is currently building 154 passive houses in Abergele in Wales, says that he can charge more for houses which are cheaper to run. This isn't just wishful thinking. A 2012 Oxford University research paper[1] found that A-rated properties commanded an 11% price premium over D-rated houses, while a 2013 Department of Energy & Climate Change report[2] found that A or B-rated homes sold for 14% more than G-rated homes. "Delivering that standard does not require a huge amount of money," says McGowan, who adds that he has faith in the industry to rise to the challenge and deliver these higher specs.

Others aren't so sure. Martin Flattery says that ▶


(opposite) Poor chimney layout leading to needless thermal bridging. Curiously thermal bridging at chimneys isn't addressed in the guidance on Part L, meaning this detail may be regarded as compliant (above) Simon Jones, commercial director UK & Ireland of ventilation technology company Aereco; (below) condensation build-up on a window in a home built during Ireland's construction boom – the clear spot is due to a leaking air seal in the window; (p68) energy consultant Mark Shirley of 2eva; (p69) good (bottom) and very bad (top) practice in terms of how to close a cavity, respectively using blockwork and an SIG insulated cavity closer

the current building environment is fraught with risks. His concerns centre on the lack of any real scientific rigour in many of the building methods that are being deployed to reach these higher standards. “Builders are adding a bit here and there, making up their own thing and ticking boxes to comply with regs,” he says.

He points out that cavity block construction with partial or full-fill cavity insulation has long been the staple of the industry. But because filling a standard width cavity with insulation alone will no longer deliver the 2011 backstop U-values, builders, instead of exploring new methods, are typically adding a warm liner to the inner leaf. Flattery points out that this piecemeal approach to achieving the new standards is far from optimal.

“A lot of the builders are sticking to what they know,” says Flattery, “and then they’ll simply supplement it to comply with regs and get an A-rated house. But you ask them where the dew point is and they haven’t a clue.” He laments the fact that there is no neutral agency to provide unbiased information on the best ways to achieve the standards required.

“An insulation company will come in and push insulation all day long with you, but they don’t care about your dew point or ventilation or fresh air or anything like that. That’s a big problem. The only education that people are getting out there comes from manufacturers.”

Another industry professional, who works for a building supply company, also cites the influence of manufacturers as a drag on standards. For obvious reasons, he didn’t want to be identified in this piece. “What we have seen in recent times is builders using a combination of insulations to achieve the regulation U-value, and it’s the cheapest way possible quite often...We see a bit of partial fill, pump or full-fill, and then a thermal liner board on the inside. It achieves the U-Value but you end up with quite a strange condensation profile in the wall.”

He points out that the cavity wall, introduced originally to prevent moisture ingress, is a hard habit to break. Because it has a long tradition in Irish building, it’s an easy sell for the industry. “The reaction is from the insulation companies of this world to get the sale of their board or their thermal liner for the inside. It’s all pushed on by them.”

The other issue with cavity insulations is moral hazard. “Builders tell you that there’s bits around corners and windows that are quite tricky to do and quite often they say, ‘sure once we get up another five or six courses of blocks, no one will know’.”

Archie O’Donnell also has concerns about dry lining your average cavity wall. In an email to Passive House Plus, he said: “It appears a sensible approach to achieve 0.18 to 0.2 U-value walls: build 100 - 120mm cavity with 60 - 80mm insulation, and then dry line it with a 50mm composite board. While this method has big advantages in that it gets very good U-Values and uses familiar skills and materials, it comes with inherent problems.”

He explains that when you split the insulation in two, the temperature of the inner leaf can drop below dew point temperature. People

Michael Donnelly Photography

assume that the foil layer on the back of the composite insulation is a vapour control layer, but that layer is compromised at joints, intermediate floors, party walls and at sockets and pipes. Moisture laden air can get through the composite insulation layer and condense on the block inner leaf.

He goes on: “We’ve noticed in recently built houses where works would be done to extend or replace windows, when we remove the dry lining, we find black mould behind it.” He says that when considering insulation strategies, you have to consider vapour management and ventilation strategies simultaneously. “The emphasis on achieving high performance airtightness and vapour control cannot be compromised.”

All of the professionals interviewed for this piece had a ready stock of stories of how poor ventilation strategies in particular, and questionable building practice in general, continue to dog Irish construction.

In July 2010, the Department of the Environment published a regulatory impact assessment (RIA) on the proposals to amend Part L of the building regs. The document included a table which listed nine separate dwelling specs as a guide to achieving compliance with the new regime. The spec for all nine included the following example: block-built cavity walls with 100 to 140mm partial fill cavity insulation in a 150mm wide cavity, and 50mm of dry lining on the inner leaf. This is exactly the kind of build-up that the experts interviewed for this article describe as problematic.

One of the most worrying aspects of the mould and condensation problems that appear in new builds is that in many cases, these houses comply fully with the requirements of the technical guidance documents, and therefore meet prima facie compliance with the building regulations. Simon Jones says that in the development where he pulled back wardrobes to find mould growth, the builder had complied “to the letter” with the technical guidance document for Part F, the section of Irish building regulations that deals with ventilation. “They have all the right holes in all the right places, the right undercuts under doors, the right fans that come on at the right times and so on, but the buildings simply weren’t ventilating adequately.”

In the aforementioned regulatory impact assessment from 2010, the sole ventilation strategy detailed in each of the nine house types was natural ventilation with between two and three extract fans – a common ventilation strategy unsupported by evidence of its efficacy, as Kate de Selincourt’s detailed investigation in issue 6 of Passive House Plus reveals. Jones says: “The technical guidance documents which support the building regulations lists just natural ventilation with intermittent fans and mechanical ventilation with heat recovery ventilation. It provides no guidance for any mechanical extract ventilation or passive stack ventilation.”

When asked why mechanical ventilation was not include in the RIA, the department issued this response: “Mechanical ventilation in the Irish residential sector is a new and growing approach. Its use is not mandatory. Regulatory impact assessments and guidance in the first instance concentrate on the most commonly used or typical approaches.”

The department’s response goes on: “The general approach taken in building regulations and the accompanying technical guidance documents is to set appropriate performance requirements and to leave it to designers to specify the appropriate solution for a particular building.”

By creating the impression that natural ventilation supplemented by extract fans in wet rooms will be sufficient to maintain indoor air quality in super-insulated, airtight homes, the regulations are making air quality hostage to commercial expediency. If a developer isn’t required to spend money on delivering a working ventilation strategy, he won’t.

“All of the evidence that we see on a weekly basis,” says Simon Jones, “and all of the evidence we see through modelling shows that there is a point at which natural ventilation and intermittent fans don’t provide adequate indoor air quality.”

Mark Shirley agrees. “Part of the problem at the moment is that DEAP [the software used to calculate building energy ratings and

Photo: Gavin Ó Sé

demonstrates compliance with Part L] can't account for any of the kinds of systems that companies like Aereco or Partel in Galway are bringing in, where you have a mechanical room vent operated quite often on a humidity sensor or carbon dioxide sensor. These are good technologies, but unless the builder is going to reap some benefit from making the investment, it's hard to see them becoming more common."

Note that the mould growth issues identified in this article all occurred before occupancy – granted, while the buildings were drying out. Add people into the mix and the potential risks may increase dramatically. In this climate, drying clothes inside is more the rule than the exception – especially in apartments – while Irish homeowners have a long history of blocking up hole-in-the-wall vents. Over-occupancy and what the industry calls 'excess' furnishings can further compromise a natural ventilation strategy.

"It's my belief that at anything below five air changes at N50," says Simon Jones, "a ventilation strategy needs to be in place that takes a large element of control away from mother nature and away from people. There's too much at stake when it comes to indoor air quality."

It is vital to point out that the problem here is inadequate ventilation, not airtightness. The common misconception about airtightness is that it is solely about the improvement of thermal performance. The reality is that it's about structure —after extensive research, the Passive House Institute settled on 0.6 air changes per hour as a target to mitigate the risk of interstitial condensation and its implications for the structure of buildings.

Moral hazard raises its head again and again in this debate. Brian Shannon of Building Envelope Technologies in Wexford says that cheap make-shift airtightness products are going into new houses all the time. He notes that while these products may deliver a target airtightness level in the short term, they will ultimately fail. "If you gave me a house that's achieving an air permeability of 20 and gave me a box of masking tape, I'd get that house down to passive standard for you, no problem, but that masking tape just won't last."

Then there's thermal bridging. As houses become more thermally efficient, thermal bridging becomes more important. If it is not adequately dealt with at key junctions, it can have a severely negative impact on the overall performance of a house. TGD L's response is that the Y-value – the total thermal bridging factor for the building – can be derived in several ways. A default Y-value of 0.15 $W/m^2k$ can be used, though this would be punitively bad in the case of buildings with even moderately good thermal bridging details, and would make compliance tricky. Building fabric consultant & NSAI accredited thermal modeller Andy Lundberg of Passivate warns that TGD L stipulates that thermal bridges must not cause mould growth. "You can use a value of 0.15 in any case, however in doing so you're stating that none of the junctions present a risk of mould growth and surface condensation, and therefore must have been assessed in accordance with the relevant standards and conventions for thermal bridge assessment. That's absolutely not being done. As one of only two NSAI certified modellers, I've not once received a phone call from anyone seeking to have junctions assessed so they can use 0.15."

Lundberg points out that the National BER Research Tool – which contains detailed information on all published BERs, including information on Part L compliance – shows 140 dwellings built in 2014 with a 0.15 Y-value listed. "One can only assume that the BER assessor in each of these cases has the relevant documentation on file to demonstrate that all junctions (non-ACD/catalogued) are free of any mould growth and surface condensation risk, which they are required to!"

Another option is to commission a certified and registered thermal bridging modelling assessor to calculate the Psi-values for each thermal bridge – potentially adding significant additional costs just to establish how good or bad the chosen details are.

Alternatively a Y-value of 0.08 can be used for details in accordance with the acceptable construction details (ACD) created to support the 2008 regs. But as Lundberg points out, the ACDs are incomplete – they don't include a door threshold detail, or other common details such as a roof insulated on the ceiling plane with a rooflight installed at rafter level. "Where a dwelling has a roof-light installed but uses a 0.08 Y-value, the conclusion can only therefore be that the BER assessor or client has had thermal modelling carried out to determine the psi-values of this and any other junction requiring assessment, and the Y-value happened to work out at 0.08 by pure coincidence." As Shannon adds, compliance with the ACDs is not independently validated.

"In DEAP, you can enter a figure of 0.08 for thermal bridging, and that will increase your thermal performance dramatically [compared to the 0.15 default]. To use that value, all you need is a letter from the developer or the architect which says you built to ACDs." He cites a recent development he visited in which extensive thermal bridging issues were utterly misrepresented in the energy rating assessment.

Energy efficiency standards for dwellings in Ireland have come a long way over the past ten years. But one developer is critical of the standards he now has to meet. Again, he asked to remain anonymous. "There's a law of diminishing returns on this environmental stuff," he says. "If you went out to buy a new car for your family, your first thoughts wouldn't be a Bentley or a Rolls Royce, you'd buy a Toyota Corolla or a middle range car... From a builder's point of view, we have now been forced to create a level of administration and that has to be paid for by the customer."

Strictly speaking, this is incorrect. As leading property economist Tom Dunne explained in this magazine's predecessor Construct Ireland[3], the market determines what price it's prepared to pay for property, and new homes must be considered as a part of the available stock that's up for sale at any given time. Buyers may be prepared to pay more, as the aforementioned reports indicate, but suppose the developer bidding to buy the land wasn't convinced. They'd work out what price they reckoned each unit might go for, deduct the construction costs – including cost of compliance with Part L – and the remainder is what they'd bid for the land. So higher construction costs aren't affecting the total development cost, but are rather causing land prices to fall to absorb the construction cost rise. Which is substituting economically unproductive spend on land for job-creating construction activity, with additional benefits in terms of reducing national energy imports and carbon emissions fines.

This kind of clamour for a relaxation in standards worries Mark Shirley. "We're building exponentially better houses now than we were five or six years ago," he says. "I think if the regulations were rolled back in any way, that would be a disaster. We have come so far."

Photo: Paul McNally

[1] Hyland, M; Lyons, R & Lyons S; "The Value of Domestic Building Energy Efficiency – Evidence from Ireland"; Oxford, 2012
[2] Fuerst, F; McAllister, P; Nanda, A & Wyatt, P; "An investigation of the effect of EPC ratings on house prices"; London, 2013
[3] Dunne, T; "Safe as Houses"; Construct Ireland Issue 5 Volume 3, 2006

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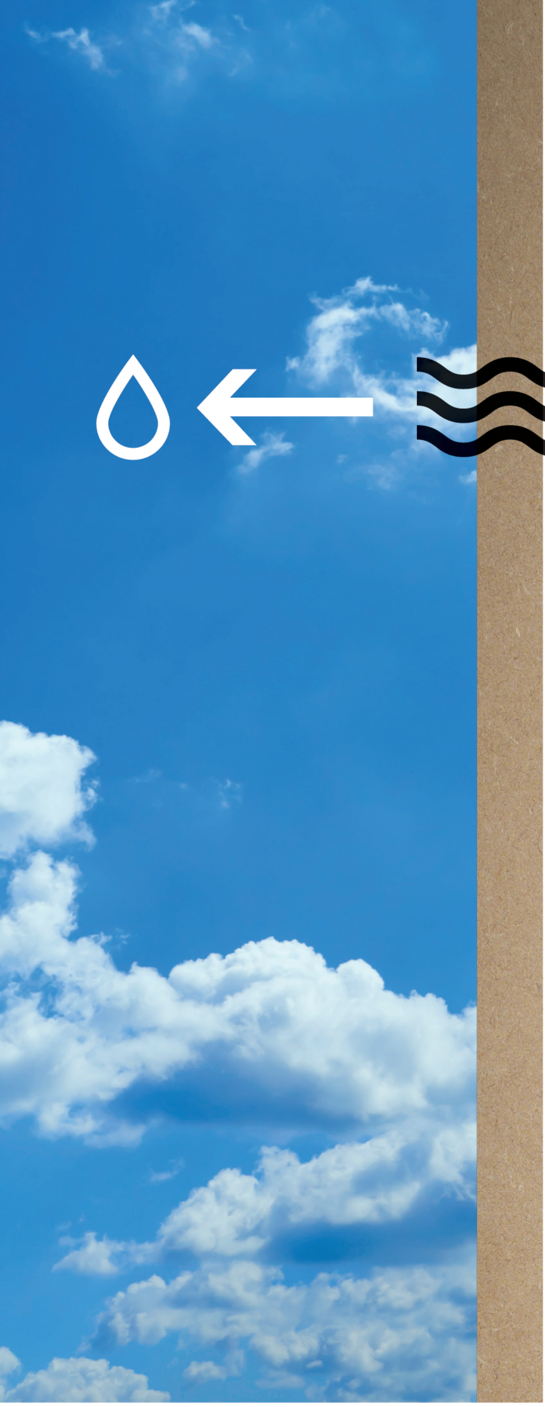

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